4.
Fauna, including Invertebrates

Session Organiser and Chairman: JOHN TAYLOR

EFFECT OF SET-ASIDE ON SOIL NEMATODE FAUNA AND VERTEBRATES IN EASTERN SCOTLAND

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ABSTRACT

Thirty six set-aside fields on twenty five arable farms in eastern Scotland were visited in June 1989, 1990 and 1991. The numbers of birds and mammals were monitored and soil samples taken which were subsequently examined for soil inhabiting nematodes. Populations of plant-parasitic, predatory and fungal/bacterial feeding nematodes increased markedly as did the detectable biodiversity of the plant-parasitic nematode community. There was a trend for an increase in some ground nesting birds especially skylark and oystercatchers. The occurrence and abundance of rabbits increased dramatically over the two year period possibly because of the greater use of harbourages in the woods and hedges around fields and the setting up of warrens within the fields themselves.

INTRODUCTION

There is some information in the literature on the host status of many agricultural crops for plant-parasitic nematodes (Taylor, 1967; Boag & Geoghegan, 1984) but virtually nothing is known about the host status of weeds which may invade set-aside fields. Rossner (1979) found weeds increased nematode populations while Thomas (1969b) also found them to be better hosts for nematodes which transmit viruses. Apart from the host crop, probably one of the major differences between conventional arable farming practices and set-aside is the fact that set-aside fields are not subjected to annual tillage regimes. Corbett & Webb (1970) found slightly greater plant-parasitic nematode populations in soil under cereals drilled after ploughing compared with those in direct seeded land. However, Thomas (1978) found highest nematode densities under non-tillage regimes while it has been shown that rotary cultivation (Oostenbrink, 1964; Boag, 1983) and compaction due to farm vehicles (Boag, 1985) can significantly reduce nematode numbers. Little is known about the effect of agrochemicals, fertilisers, herbicides, insecticides and fungicides on many non-target organisms including nematodes. What evidence there is suggests they do not generally have a significant effect on nematode numbers but Trudgill (1982) has reported significant decreases in *Longidorus elongatus* populations when the fungicides benomyl and quintozene were incorporated into the soil.

The interaction between agricultural practice, land use and vertebrates has received a great deal of attention, including reviews for major farmland birds (O'Connor & Shrubb, 1986) and game birds and mammals (Boag, & Tapper, 1992). Since the withdrawal of many insecticides in the 1960's and 1970's the populations of some species of birds have increased significantly (Sommerville & Walker, 1990). However, while the effects of some land use changes in Britain can be forecast (Britton, 1990) there is virtually no information on the long term effects of set-aside which was only introduced in 1988.

The purpose of the present paper was to present preliminary results obtained between 1989 and 1991 of the effect of set-aside on both plant-parasitic nematodes and vertebrate pests.

MATERIAL AND METHODS

Forty questionnaires were given to East of Scotland College advisors in Perthshire, Angus and Fife to be given to farmers who had submitted land in 1988 for set-aside asking whether they were willing for their land to be visited and monitored for wildlife, and for soil samples to be taken. Of the forty, three responded, of which eight were in rotational set-aside and were excluded from subsequent visitations.

Visits were carried out in June of each year (1989-91) during which the perimeter of set-aside fields were walked, signs of the presence of rabbits noted, plus the numbers of rabbits, and presence of hares and numbers and species of birds recorded. Soil samples, made up from at least twenty subsamples, were collected from a depth of 2-12 cm and returned to the laboratory in numbered polythene bags. In the laboratory nematodes were extracted from a 200 g subsample using a modification of a sieving and decanting technique (Boag, 1974) the rest of the soil being used for soil analysis or frozen for subsequent weed seed analysis.

Nematodes were heat killed and stored in triethanolamine formalin (TAF) before being counted. Half of the nematodes were then transferred to pure glycerol and mounted on rectangular clover slips on 76 mm x 52 mm slides before being identified.

RESULTS

The nematode data from 17 fields can be seen in Table 1. The numbers of nematode in all groups i.e. plant parasitic nematodes, fungal/bacterial feeders and predatory nematodes increased between 1989 and 1991. Of the three groups the proportion of the overall nematode fauna represented by plant-parasitic nematodes fell from 22% in 1989 to 17% in 1991 while the other two groups increased. Within the plant parasitic nematodes the abundance of *Paratylenchus* species increased from 46 to 177/200 g soil between 1989 and 1990 while comparable figures for the genera *Tylenchorhynchus* were 41 and 84 and for *Helicotylenchus* 16 and 56.

Both the signs of rabbits and the numbers seen on the twenty five farms and thirty six fields showed the occurrence and abundance of rabbits to increase markedly between 1989 and 1991 (Table 2). In 1989 rabbits were only seen on seven farms but this increased to eighteen i.e. 72% by 1991. Similarly rabbits were observed in eleven set-aside fields in 1989 but twenty seven by 1991, an increase from 31% to 75% of the thirty six fields visited. However, the greatest increase between 1989 and 1991 was that of the number of rabbits seen. In the first year a total of thirty two were counted, in 1990 this had risen to 100 while one year later 470 were observed. Very few brown hares were seen but no

TABLE 1. Occurrence and abundance of soil inhabiting nematodes in set–aside fields (n = 17) in eastern Scotland

Genera/Feeding group	1989 Occurrence (No. fields + ve)	1989 Abundance (Nematodes 200 g soil)	1990 Occurrence (No. fields + ve)	1990 Abundance (Nematodes 200 g soil)	1991 Occurrence (No. fields + ve)	1991 Abundance (Nematodes 200 g soil)
Plant parasitic nematodes	17	206	17	259	17	473
Criconematids	0	0	0	0	6	2
Helicotylenchus	9	16	8	21	13	56
Longidorus	11	8	11	26	12	11
Merlinius	4	9	9	41	9	38
Paratylenchus	10	46	10	69	14	177
Pratylenchus	7	78	9	26	13	76
Rotylenchus	6	8	5	5	6	29
Tylenchorhynchus	10	41	10	71	11	84
Predatory nematodes	11	18	16	26	15	66
Fungal/bacterial feeding nematodes	17	707	17	1021	17	2317
Overall total		931		1306		2856

TABLE 2. Occurrence and abundance of rabbits (*Orytolagus cuniculus*) and hares (*Lepus europaeus*) in farms (n = 25) and set-aside fields (n = 36) in eastern Scotland

	Year		
	1989	1990	1991
Number of farms with signs of rabbits in set-aside fields	14	17	21
Number of farms when rabbits were seen in set-aside fields	7	11	18
Number of set-aside fields with signs of rabbits	18	23	29
Number of set-aside fields in which rabbits were seen	11	15	27
Number of rabbits seen in set-aside fields	32	100	470
Number of set-aside fields in which hares were seen	2	4	3
Number of hares seen in set-aside fields	3	9	5

significant trend similar to that seen in the rabbits was recorded.

Over twenty species of bird were identified. Numbers were generally either too few or too erratic for any meaningful trends to be observed with the possible exception of skylarks and oystercatchers. The number of fields in which skylarks were seen increased from five to twenty and numbers counted ten to fifty eight while comparable figures for oystercatchers were four to nine and eight to twenty.

DISCUSSION

The preliminary results of the nematode data from the seventeen set-aside fields suggests that both the total number of nematodes and their biodiversity had increased. The doubling of the total plant-parasitic nematode population is similar to the rates of multiplication previously recorded in experiments in permanent grassland in eastern Scotland (Boag, 1982). Of the genera recorded *Paratylenchus* has been shown to be able to multiply rapidly (Boag & Alphey, 1988) while *Longidorus* sp. may have a life cycle in excess of a year (Thomas, 1969a). The average number of plant-parasitic genera detected in set-aside fields rose from 3.3 in 1989 to 4.9 in 1991 and possibly reflects the increase in host plants due to the introduction of weeds.

Rabbit numbers in Britain increased after myxomotosis reduced their numbers in the 1950's (Trout *et al.*, 1986) until by 1986 it was the major vertebrate pest species, causing an estimated £100 million pounds of damage (Mills, 1986). In spite of intensive modern agricultural practices which can reduce rabbit populations Boag (1987) their numbers have increased. The continued reduction in the effectiveness of myxomotosis, due to both increased resistance (Ross & Sanders, 1984), the increase in more attenuated strains (Fenner & Chapple, 1965), together with increased costs of control and have also contributed to this growth. If set-aside is extended to cover 15% of the arble land in Great Britain the results here would suggest that rabbits may become an even greater pest. The 14.6 fold increase in numbers of rabbits counted between 1989 and 1991 can possibly be explained by their increased use of woods and hedges around fields, and by warrens being set up within some of the fields themselves. This had lead to four of the farmers putting up additional rabbit netting around their set–aside fields to both prevent some rabbits gaining access to the set–aside fields and to stop others using the set–aside fields as harbourages from which to move out into more traditionally cropped arable fields. The introduction of new woodland schemes and set–aside may have exacerbated the situation still further.

Many of the birds recorded between 1989 and 1991 have been commonly found in agricultural land in most of Great Britain (O'Connor & Schrubb, 1986) the possible exceptions being curlew and oystercatcher. Preliminary results would suggest that both these species (plus skylark and possibly lapwing and pheasant) benefit from set–aside while no consistent trend was seen in most of the others. A possible explanation is that, as ground nesters, these birds are more likely to succeed on land which is not mown until the young birds have flown. Other contributing factors may be the increase in invertebrates and seeds as a source of food and less disturbance in the set–aside fields. It is interesting to note that partridge numbers did not follow this trend although the introduction of managed headlands has been shown to be successful (Rands, 1987; Boatman & Wilson, 1988). A possible explanation is the lack of predator control in set–aside fields which would allow corvids to take nesting birds/eggs and foxes catch incubating hens (Tapper *et al.*, 1991).

In the long term the wide scale introduction of set–aside throughout Great Britain will have a profound effect on both soil nematode fauna and wildlife. While it maybe of benefit to certain species of birds, pests will also increase and the cost of managing/controlling them must be taken into consideration when advocating and establishing set–aside fields.

ACKNOWLEDGEMENTS

I should like to thank the Scottish Agricultural College advisors for help in obtaining the list of farmers with set–aside fields, the farmers themselves for allowing me to take samples and monitor the wildlife on their farms and to Scottish Office Agriculture and Fisheries Department for financial support for this work.

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GROUND BEETLE COMMUNITIES ON SET-ASIDE AND ADJACENT HABITATS.

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ABSTRACT

Ground beetle communities found in various habitats on a farm in NE Scotland were assessed to investigate to what extent semi-natural habitats determine the fauna in adjacent set aside land. More species and individuals were caught in set -aside than in either adjacent semi-natural or cultivated areas. The communities caught in first and second year set-aside resembled those caught in cultivated areas more than those caught in semi-natural habitats. Species characteristic of each habitat were identified.

INTRODUCTION

Set-aside, although introduced to reduce agricultural production of selected crops, may be of benefit to wildlife conservation and increase the species diversity of farm ecosystems. Many farms contain within their boundaries areas of semi-natural vegetation in the form of small woodlands, copses or watercourse embankments which contain a diversity of wildlife. If such areas are to be used as foci from which species can move to exploit land released from agricultural production, then it is important to understand the extent to which this happens.

Ground beetles (Carabidae) have been used extensively in the classification of habitat types (e.g. Dufrêne *et al.*, 1990) and in assessing the effect of perturbations within habitats (e.g. Rushton *et al.*, 1990). They are well known in agricultural research due to their beneficial role as polyphagous predators and as indicators of pesticide side effects. Their value as bioindicators is due to their relative ease of capture, their ease of identification (at least of adults), their responsiveness to environmental conditions, their mobility and their widespread distribution.

The aim of this study was to determine to what extent ground beetle communities found in set-aside resembled those found in adjacent semi-natural or cultivated areas.

METHODS

Study site

The study was conducted at Aberdeen University's Aldroughty Farm near Elgin, Morayshire, in NE Scotland. In October 1988, some of the least productive areas on this 94 ha mixed arable/livestock farm were taken out of cereal production under the fallow option of the UK set-aside scheme. Invertebrate studies concentrated on two of these areas, in Fields A and C, selected due to their proximity to well established semi-natural habitats. In Field A (3.3 ha), a headland was set aside forming a 110 m x 40 m corridor between an adjacent wood and partially drained bog (see Jones *et al.* (1991) for a description of the vegetation). In Field C (4.6 ha), a 24 m wide set-aside strip ran along the 230 m length of one field boundary adjoining a raised canal bank. Both set aside areas were left in stubble after harvest allowing plant cover to regenerate from naturally occurring vegetation. Thereafter, the vegetation was cut and left in late September. In 1990, the crop grown in Field A was spring barley and in

Field C was seed potatoes. The soil type in Field A is loamy sand to sandy loam, while in Field C it is silt loam.

In addition, ground beetles were studied in a third field, Field B (3.6 ha). After harvest in 1989, four 40 m x 15 m set-aside plots were established along its field boundary adjoining the bank of the River Lossie. The vegetation was left to regenerate from stubble and cut and left in late September 1990 (see Jones *et al.*, 1991). These plots were interspersed, according to a randomized block design, with four cultivated plots, of similar size, treated in the same way as the rest of the field. The crop grown was spring barley. The soil type is loamy sand.

Sampling regime

Ground beetles were collected at approximately monthly intervals, between February and October 1990, using plastic pitfall traps arranged in regular grids or transects covering semi-natural, set-aside and cultivated areas. In Field A, 12 traps were set in the wood, 12 in the bog, 18 in set-aside and 18 in the crop forming a 6 x 10 grid. In Field B, three transects of 40 traps were placed running parallel to the river bank; one transect in the river bank, one through the set-aside and spring barley plots (20 traps in each of set-aside and crop) and another further out in the spring barley crop. Three transects of 11 traps, perpendicular to the canal bank, were employed in Field C such that 6 traps were in the canal bank, 9 traps in set-aside and 18 traps in the potato crop. Each trap, partially filled with 1% formalin killing fluid, was opened for four days on each sampling occasion. Both adult and larval ground beetles collected were identified to species, whenever possible.

Multivariate analysis

The presence and absence of adult and larval species caught in each pitfall trap over the whole sampling period were used to form sample by species data matrices for each field. The data matrices were ordinated by detrended correspondence analysis (DCA) using the FORTRAN program DECORANA (Hill, 1979). Samples which were found to be outliers in the analyses were removed and the affected data matrices were reanalysed.

DCA enables the reduction of multidimensional data (typically dozens to hundreds of species or samples) to a few dimensions (typically one to four). The transformed data, represented by axes scores or coordinates, can then be plotted as scatter diagrams using the derived axes. Distances between samples in DCA scatter plots are a measure of between-site variability in species composition: sites plotted close together being more similar than sites further apart. The size of polygons drawn to enclose all samples from one site gives a comparative indication of the intrinsic variability of that site.

RESULTS

Between February and October 1990, 45 species of ground beetles were caught in semi-natural, set-aside and cultivated areas in, or adjacent to, the three studied fields. Adults of *Nebria brevicollis*, *Trechus quadristriatus*, *Bembidion tetracolum*, *Bembidion lampros* and larvae of *N. brevicollis* were the most widespread and, frequently, the most numerous ground beetles caught in pitfall traps. Other species were prevalent in some habitats, e.g. *Bembidion guttula* and *Trechus obtusus* in the bog, *Calathus piceus* and *Carabus problematicus* in the wood, *Leistus rufescens* and *T. obtusus* in the river bank and *Amara plebeja* in set-aside areas.

More species and individuals were caught in set-aside areas than in semi-natural and, to a lesser degree, cropped areas in the respective fields (Table 1). Even after numbers caught were adjusted according to the different sampling efforts in the various habitats, this relationship still held true. Estimates of the number of species caught in a standard number of traps in each habitat were derived from plots of cumulative number of species caught against number of traps employed.

TABLE 1. Numbers of (i) species and (ii) individuals caught in 100 sampling units, where 1 unit = 1 trap x 1 sampling occasion, between February and October 1990. (Actual numbers caught in brackets). Values for both semi-natural habitats, a) bog and b) wood, in Field A are given separately.

(i) Species:

	Semi-natural	Set-aside	Crop
Field A	a) 7 (7) b) 11 (11)	25 (29)	23 (27)
Field B	16 (24)	27 (29)	22 (26)
Field C	18 (14*)	20 (19)	17 (19)

(ii) Individuals:

	Semi-natural	Set-aside	Crop
Field A	a) 54 (57) b) 168 (181)	662 (1073)	365 (365)
Field B	47 (149)	658 (1053)	402 (1928)
Field C	90 (43)	699 (503)	328 (472)

The difference between semi-natural ground beetle communities and communities in set-aside was also demonstrated by the DCA scatter plots of sample scores (Fig. 1). Relative to semi-natural habitats, set-aside communities were indistinguishable from cultivated areas. Set-aside and cultivated areas were also, generally, more uniform in terms of their species composition than semi-natural habitats, in the respective fields, demonstrated by the area occupied by their polygons. After exclusion of semi-natural samples from data matrices, removing their over-riding effect on the ordination of samples from other habitats, some differences in the species composition of set-aside and crop samples became apparent (Fig. 2), particularly between the potato crop and the set-aside strip in Field C.

DISCUSSION

Care must be taken in interpretating pitfall trap data, as the number caught is dependent on both population density and activity. Factors such as micro-climate, vegetation structure and prey densities may affect activity and, inadvertently, the trap catch (Greenslade, 1964). Consequently, particular care is necessary when comparing catches from different habitats. Environmental variables (e.g. plant cover, vegetation height) were recorded at each trap location on a number of sampling occasions and the activity in different habitats of selected species have since been studied by mark/recapture and radar tracking methods. These data will be presented elsewhere.

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* 3 traps were positioned at the canal bank/set-aside interface resulting in the capture of 12 of these species, while only 3 species were caught in the canal bank proper.

Figure 1. Axis 1 by axis 2 scatter plots of DCA ordination sample scores from semi-natural, set-aside and cultivated areas in (a) Field A, (b) Field B and (c) Field C. Polygons enclose all samples of each habitat studied.

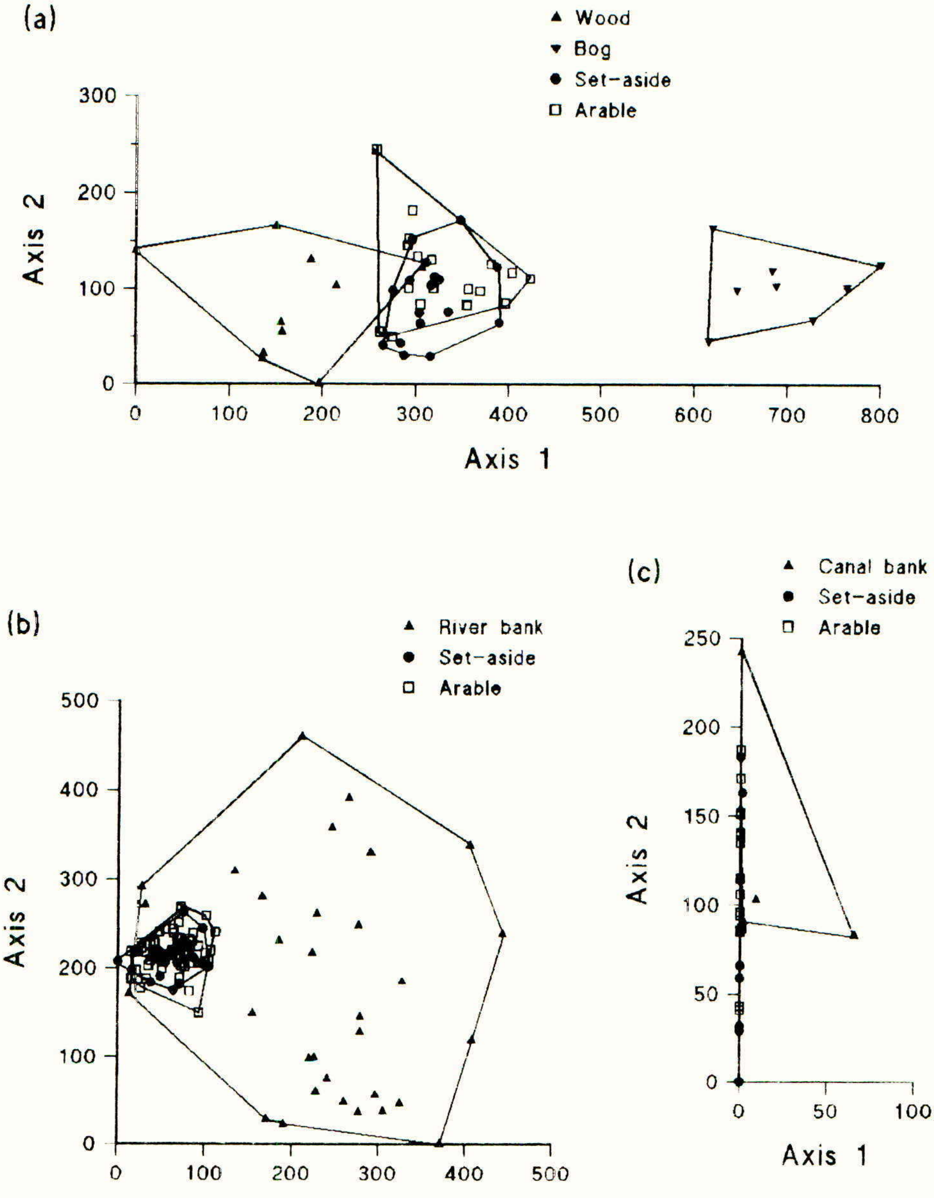
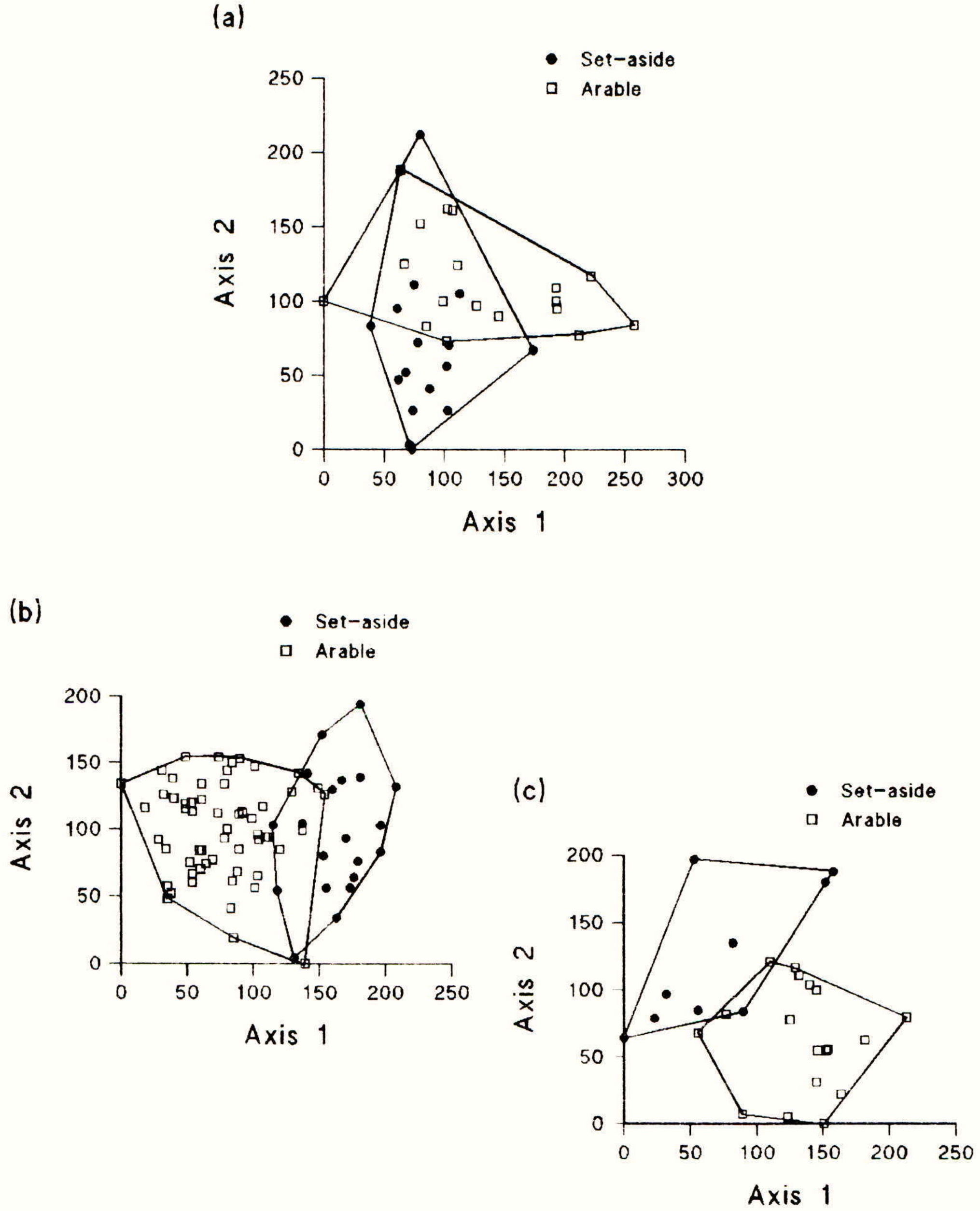


Figure 2. Axis 1 by axis 2 scatter plots of DCA ordination sample scores from set-aside and cultivated areas in (a) Field A, (b) Field B and (c) Field C. Polygons enclose all samples of each habitat studied.



The large number of individuals caught in set-aside compared to those caught in the crop probably reflect a real difference, since the reverse would be expected based on the regular, wide spacing between plants and greater proportion of bare ground in the crop imposing less resistance to activity than in the more densely vegetated set-aside. The number of species caught and the presence/absence of all but the rarest species are less likely to be affected by activity.

Extrapolating from data of ground beetles caught in areas in their first and second year of set-aside, the areas studied adjacent to semi-natural habitats are unlikely to form extensions of such habitats within the five year period of the set-aside scheme. Ground beetle communities on set-aside seem, instead, to be more closely related to those in adjoining cultivated areas. This may be due to arable species remaining resident after set-aside areas are taken out of agricultural production, and/or due to highly mobile and invasive species, characteristic of open and cultivated areas, dispersing into set-aside. Nevertheless, in time, less mobile and invasive but more competitive species are expected to play an increased role in set-aside areas. Species more characteristic of one habitat than the other can be identified, as indicated by the separation between set-aside and crop polygons in Fig. 2. For example, *Amara plebeja* was found almost exclusively on set-aside (98% of 642 individuals) while *Bembidion tetracolum* was found mainly in cultivated areas (91% of 253 individuals).

Set-aside may play a role for ground beetles as a refuge from adverse agricultural practices and therefore act as a source of potential reinvasion of cultivated areas after, for example, broad spectrum insecticide treatments. The benefits of establishing refuges for potentially beneficial predator populations are discussed in Thomas & Wratten (1988). In addition, the enormous number of seeds shed on set aside land (Jones & Naylor, 1992) may also make set-aside a favourable habitat for spermophagous species (e.g. *A. plebeja*).

ACKNOWLEDGEMENTS

I thank Dr. M.R. Young for his supervision and Mr. J. Booth and his staff for management of set aside areas. This study was funded by NERC through the Joint Agriculture and Environment Programme.

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SET-ASIDE FALLOW OR GRASSLAND: RESERVOIRS OF BENEFICIAL INVERTEBRATES?

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ABSTRACT

The abundance of beneficial invertebrates was monitored on natural regeneration (fallow), ryegrass and arable plots at Boxworth E.H.F. and on nearby set-aside fields at Conington. At Boxworth, populations of ground beetles and rove beetles were highest in the arable (winter wheat) plots while spider populations were particularly high in grassland in early summer. Results from set aside fields were generally similar to the natural regeneration experimental plots except that spider populations were higher in autumn on the fields. The potential of such fields as a reservoir of natural enemies of pests is discussed.

INTRODUCTION

This paper considers the proposition that set-aside fields may have benefits for adjacent areas of arable crops by providing a reservoir of beneficial invertebrate species. This is in keeping with the accepted role of hedgerows, and, more recently, grassland strips as a source of predatory insects like carabid (ground) and staphylinid (rove) beetles which colonise crops and can feed extensively on pests such as aphids (Thomas and Wratten, 1988). The data reported here represents a 'first look' at the abundance of carabid species in set-aside fallow in Cambridgeshire and in a range of experimental plots representing different methods of set-aside land management at Boxworth Experimental Husbandry Farm.

STUDY SITE AND METHODS

At Boxworth E.H.F. a range of set-aside and alternative management experimental plots have been set up in an ADAS study concentrating primarily on floristic richness and succession. Each treatment is represented by four 24 x 12m replicate plots, one in each of four blocks, with a total of twelve treatments per block. All plots and blocks were separated by 12m strips of permanent grassland. For this study, five treatments were compared:

1. Perennial ryegrass (cut x2/year)
2. Perennial ryegrass with white clover (cut x 2/year)
3. Natural regeneration (cut x1/year)
4. Arable - winter wheat
5. Natural regen. + management (cut x1 + shallow cultivated)

The two natural regeneration treatments showed differences in vegetation when monitored in November 1990 (ADAS survey). In particular, treatment 3 had a very high population of volunteer cereals (489 plants m^{-2}) compared to treatment 5 (14 plants m^{-2}).

Four pitfall traps (each approximately 9 cm deep x 6.5cm diameter) were positioned at 5m intervals down the centre of each plot. This provided sixteen traps per treatment. Traps contained a small quantity of water plus detergent and were left out for three periods of seven days during 1991. Catches were collected on: 26th June, 25th October and 1st November 1991.

Treatments 1 and 2 were cut on 22nd May and 5th July 1991. Treatments 3 and 5 were cut on 22nd August and treatment 5 was also tine cultivated on 20th September. None of these four treatments received any sprays. The arable plots (treatment 5) were sprayed with fungicide (fenpropimorph and propiconazole) on 28th June 1991 and were harvested on 12th August. They were then disc and tine cultivated on 14th August and drilled (and rolled) with winter oats on 17th October 1991.

The second study site was at Conington, approximately 2.5 km from Boxworth, where a number of fields have been in set-aside since the autumn of 1989. Here, two blocks of 4 x 4 pitfall traps at 5m intervals were positioned in two adjacent fields which previously carried a crop of broad-beans (Field 14) and spring wheat (Field 12) respectively. After two seasons of set-aside, the fields appeared floristically different and this was confirmed by vegetation survey. The bean field was dominated by blackgrass (*Alopercurus myosuroides*) and soft brome (*Bromus hordeaceus*), while in the spring wheat field couch grass (*Elymus repens*) was dominant along with blackgrass and extensive growth of curled docks (*Rumex crispus*). The fields were cut on 17th July 1991 and sampled for invertebrates in the same way as the experimental plots. Catches were collected on the following dates: 18th October, 25th October and 1st November 1991.

RESULTS

Ground (Carabid) Beetles

Catches of ground beetles were generally low at both sites (Figs. 1(A) and 1(B)). At Boxworth the early summer catch was dominated by *Pterostichus* spp., and mean catches of carabids were significantly higher ($P<0.05$) in the arable and managed natural regeneration treatments than in the grassland. In the autumn, the catch at Boxworth was dominated by *Trechus quadristriatus* which occurred in significantly higher ($P<0.05$) numbers on the arable plots than in any of the other four treatments.

At Conington, catches of ground beetles, particularly *T. quadristriatus*, were higher on the 'broad bean' set-aside field compared to the 'spring wheat' field. Numbers caught in mid and late October were broadly comparable to equivalent samples from the natural regeneration plots at Boxworth.

Rove (Staphylinid) Beetles

Autumn catches of rove beetles at Boxworth were consistently and significantly higher ($P<0.05$) in the arable plots than in the grassland and natural regeneration treatments (Figs. 2(A) and 2(B)). At Conington, catches were similar in both fields, but in mid-October were much higher (approximately x4) than equvalent catches in natural regeneration at Boxworth.

Spiders

Spiders were caught in much higher numbers than ground or rove beetles, particularly in the summer catch at Boxworth (Fig. 3(A)). Numbers were particularly high in the grassland plots, but low in the arable. Catches in the two Conington fields (Fig. 3B) were very similar, but, particularly for the mid-October catch, were much higher (> x 5) than in the natural regeneration plots at Boxworth.

DISCUSSION

On the experimental plots, the arable treatment could be taken as a 'baseline' against which to compare the suitability of set-aside and other treatments as a refuge for high densities

Fig. 1 Total pitfall catches of Carabidae at (A) Boxworth and (B) Conington, sampled during 1991

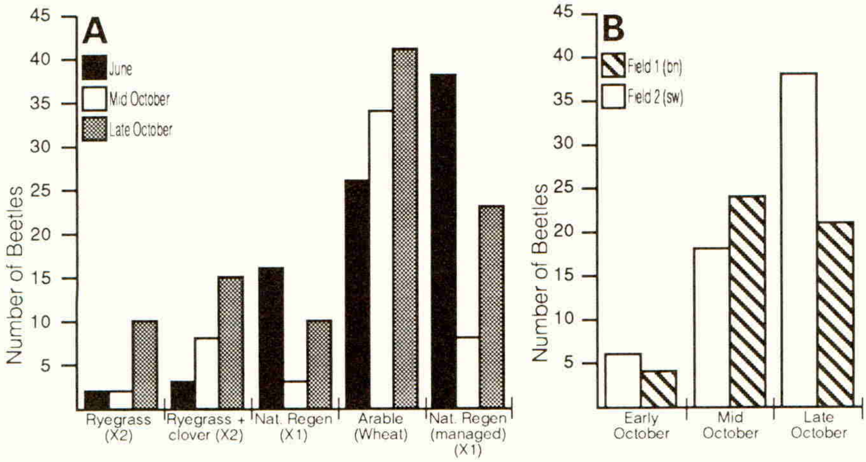


Fig. 2 Total pitfall catches of Staphylinidae at (A) Boxworth and (B) Conington, sampled during 1991

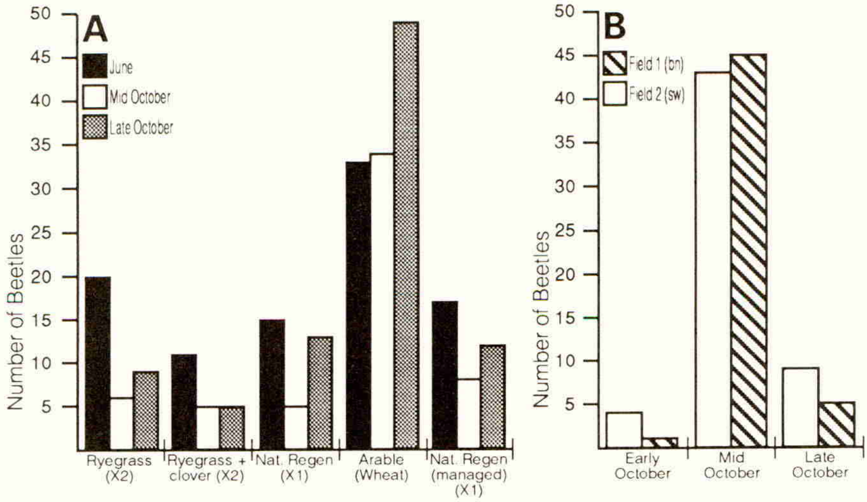
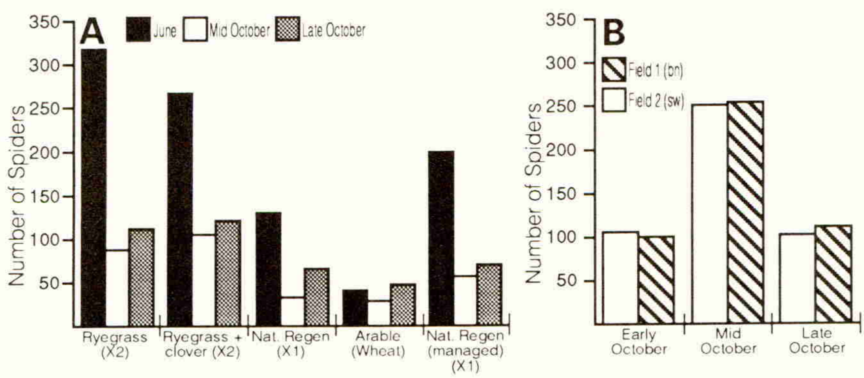


Fig. 3 Total pitfall catches of Spiders at (A) Boxworth and (B) Conington, sampled during 1991



of predatory beetles and spiders. Although the results of pitfall trapping need to be treated cautiously and should be corroborated by other sampling methods, first indications are that populations of ground beetles and rove beetles are no higher in natural regeneration ('set-aside') or grassland plots than in the arable plots. While there was little difference in the autumn, the arable plots in fact had the highest species count in the summer catch. Only spiders appear to benefit (in early summer) from converting land from arable to set-aside, or even more beneficially, to grassland. Results for the set-aside fields were broadly in agreement with the results from the experimental plots, but mid-October catches of spiders were very much higher.

The results obtained are contrary to what might be expected. An arable field is subject to extensive physical disturbance several times in each year by a variety of cultivation activities and would not seem to be a particularly favourable habitat for invertebrates. This physical disturbance is often coupled with spraying of herbicides and pesticides and stubble burning. For invertebrates which cannot fly, mortalities are likely to be high. Undoubtedly, such fields rely on colonisation from surrounding habitats and there is good evidence for such movement of some ground beetles (Sotherton, 1984). However, many ground and some rove beetles are flightless, which limits migration distance. Despite this, some species like the ground beetle *Trechus quadristriatus* are particularly abundant in arable fields and clearly cope well with the temporary nature of such habitats.

Comparison of the two natural regeneration treatments further demonstrated that physical disturbance need not always have adverse effects on invertebrate fauna. The addition of shallow cultivation to mowing of natural regeneration plots either had no effect or increased catches of some insects. However, there is evidence from other studies (e.g. Morris 1990, Gibson *et al* 1992) that disturbance associated with mowing or grazing of grassland can reduce invertebrate abundance.

Although densities of predatory beetles were not particularly high in any of the set-aside or grassland areas surveyed, extensive areas of such habitat will undoubtedly provide a larger reservoir of predatory beetles capable of colonising adjacent arable fields. Similarly, spiders of the family Linyphiidae can disperse effectively between fields by aerial 'ballooning'. Depending on dispersal ability, some predators may only colonise field edges while others will spread throughout an arable field.

ACKNOWLEDGEMENT

We would like to thank ADAS and the Boxworth Experimental Husbandry Farm for permission to collect samples from the set-aside experimental plots.

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THE EFFECTS OF SET-ASIDE FIELD MARGINS ON THE DISTRIBUTION AND BIOCONTROL POTENTIAL OF POLYPHAGOUS PREDATORY ARTHROPODS IN ARABLE CROPS

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ABSTRACT

The effect of a 15m set-aside field margin (site A) on the distribution and biocontrol potential of Carabidae and Lycosidae was studied in comparison with a 5m field margin (site B) and a conventional 'no margin' system (site C). Activity density estimates suggested that after three years there was enhancement of the population of several species of Carabidae in the arable crop adjacent to the 15m margin and to a lesser extent in the crop adjacent to the 5m margin. In 1991 the weed flora in the margin and crop at site A was dominated by the perennial grass *E. repens.* A significant negative correlation was found between the light intensity at the soil surface and the activity density of *P. melanarius* in the crop. The role of the margins in predator density enhancement is discussed in relation to data from directional gutter-trapping experiments.

INTRODUCTION

The ability of polyphagous predatory arthropods to limit the growth of aphid populations has received a great deal of attention in recent years (Edwards *et al*, 1979; Nyffeler & Benz, 1988; Winder, 1990). Several authors have reported the importance of field boundaries for overwintering (Edgar & Loenen, 1974; Sotherton, 1985; Desender *et al*, 1989) and subsequent re-population of arable land by epigeal organisms in the spring (Wallin, 1985; Coombes & Sotherton, 1986). Field margins and alternative uncropped systems within and around arable fields have been shown to enhance populations of beneficial insects such as Carabidae (Coleoptera) and Lycosidae (Araneae) (Von Klinger, 1987; Nentwig, 1989; Thomas *et al*, 1991) and enlargement and sustained vegetation management of these areas may increase the biocontrol potential of the predators (Gravesen & Toft, 1987; Basedow, 1988).

The adjacence of such areas to crops may lead to invasion of the cultivated area by pernicious arable weeds. However, previous studies have shown that selective management can reduce the damaging impact of field margins on the crop whilst providing a stable and diverse ecosystem (Marshall, 1989; Smith & Macdonald, 1989). Indeed, the presence of weeds in the crop itself has been shown to enhance the activity abundance of natural enemies (Speight & Lawton, 1976; Powell *et al*, 1985; Chiverton & Sotherton, 1991), possibly by reducing light intensity at the soil surface (Alderweireldt & Desender, 1990). This investigation examined the spatial distribution of Carabidae and Lycosidae in extended field margins and adjacent crops, and the effects of weed invasion on the activity density of ground beetles in relation to their potential to limit aphid population expansion.

METHODS

The study sites

Field margins were initiated after harvest in autumn 1988 at three study sites located in two adjacent fields of approximately equal size (10-ha) separated by a 2m farm track and a 5m deep wooded strip containing hawthorn and ash. Site A was a 100m length of a field boundary under the MAFF permanent fallow option of the set-aside scheme, with its north-east and south-west edges adjoining woodland. During the first year the margin's vegetation was dominated by annual grasses and broad-leaved weeds (Kielty, unpublished), with secondary succession in the following years leading to dominance by perennial grasses, mainly couch-grass (*Elymus repens*). The hedge bank itself was predominantly annuals such as barren brome (*Bromus sterilis*) interspersed with perennials such as cocks-foot (*Dactylis glomerata*). Sites B and C were situated in the same field and the 5m margin at site B backed onto the woodland at the north-east edge of site A. Succession to perennial species was more rapid on this margin with dense couch-grass during the second year. Site C had no extended field margin but the hedge bank was backed by a woodland.

Pitfall trapping

The spatial distribution of Carabidae and Lycosidae (in terms of activity density) was determined by pitfall trapping between March and September in 1989, 1990 and 1991. The traps were (plastic beakers 12cm deep x 9cm diameter) were placed along a 65m transect from the hedge base into the crop, replicated ten times along sites A and B in 1989 and six times at all three sites in 1990 and 1991. Data from the replicate traps at each position along the transect was pooled for each site and the mean number of predators per trap per week was calculated. The activity density in the margin and crop at each site over the trapping period was analysed by a one-factor analysis of variance on a log (n+1) transformation of the mean data for each sample date.

Weed density and micro-climate assessments

The crop weed flora at site A in 1991 was dominated by couch-grass. The mean shoot density in a 1m^2 area around each of twelve pitfall traps was assessed in July '91. Traps were emptied morning and evening for eleven days in August '91 during which several micro-climatic parameters were recorded hourly using *Squirrel* data-loggers around the traps at 65m from the hedge base: Soil and air temperature (at -10cm, soil surface and +30cm) and relative humidity. Light intensity at the soil surface around each of the twelve traps was determined by twenty light readings per 2m^2 to allow a mean light intensity to be calculated.

RESULTS

The spatial distribution of Carabidae and Lycosidae

In the three years of this study 44 species of Carabidae (representing 20 genera) and 5 species of Lycosidae (representing 3 genera) were caught in pitfall traps at the sites. However, in each year a few species dominated the catch: In 1989 the carabid with greatest activity abundance at sites A and B was *Nebria brevicollis*. In 1990/91 at all three sites it was *Pterostichus melanarius*. *Pterostichus madidus*, *Pterostichus cupreus* and *Harpalus rufipes* provided the bulk of the remaining catch. In 1989 the wolf spider with the greatest activity abundance at all sites was *Pardosa amentata* while in 1991 it was *Trochosa ruricola*. In 1990 numbers of Lycosidae at site A were low in comparison with the other two years and there was no apparent dominance by either species.

With the exception of site A in 1989, more adult carabid beetles were caught per pitfall per week in the crop than in the margin (see figure 1a). The differences were significant (P<0.05) except for site A in 1991 (0.08>P>0.05) and 1989 (P>0.2). Significant differences were found between lycosid spiders in the margin and crop at sites A and B in 1989 and at site C in 1990 (see figure 1b). Although more spiders were caught in the margin than the crop at all sites in all years variance between sample dates and replicates was high and the mean weekly catch low.

The effect of weeds on carabid activity abundance

The mean density of *E. repens* around the traps, mean light intensity, and recorded micro-climatic factors with the corresponding catch of carabids are presented in table 1. A significant

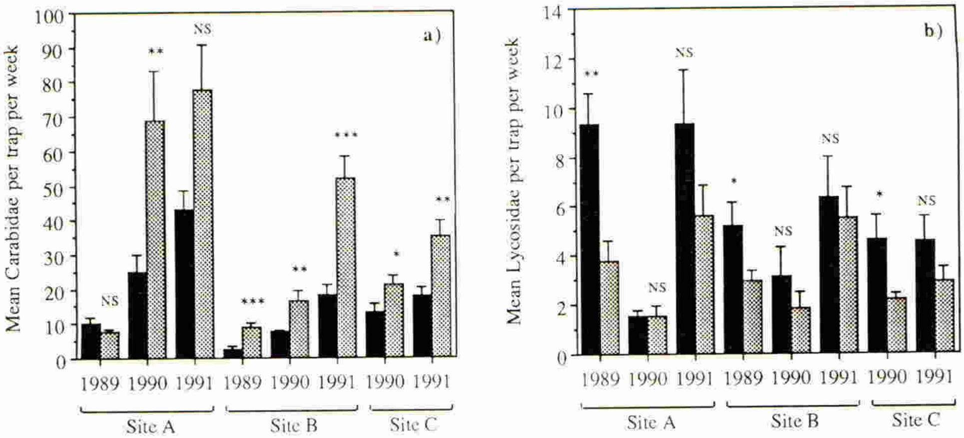

Figure 1. The mean number of a) Carabidae and b) Lycosidae per trap per week in the margin (■) and crop (▩) over the entire trapping period at Sites A, B and C. Comparison between the two habitat areas was by a one-factor analysis of variance on a log (n+1) transformation of mean data. (*** =P<0.001, ** = P<0.01, * = P<0.05, NS = not significant).

negative correlation was found between light intensity at the soil surface and the activity abundance of Carabidae (see figure 2). The number of *P. melanarius* caught during the daytime was greater at lower light intensities: The total catch was greater when light penetration was reduced. No such relationship occurred between the density of couch-grass and the catch. Light intensity was not always a function of weed density but also variation in the crop stand canopy density (Kielty, unpublished). No significant differences were found between the three temperature profiles during the period and also between the mean temperature and relative humidity at the four recording sites.

DISCUSSION

Although 44 species of Carabidae were caught during the study the catch at each site in each year was dominated by one or two species, a trend which is not uncommon (Jones, 1976; Thiele, 1977). *N. brevicollis* is often associated with disturbed ground (Meijer, 1974) and woodland (Penney, 1966) and the location of sites A and B may have facilitated the rapid colonisation in the spring of 1989. However, in the two subsequent years the carabid fauna was dominated by *P. melanarius*. This species is a summer and autumn breeder with winter larvae and is commonly associated with arable fields. After reproduction and when field conditions become unfavourable (e.g. post-harvest) adults may search for overwintering sites in adjacent, uncultivated habitats such as woodlands (Wallin, 1985; 1986). Repopulation of the cultivated area in the following spring by survivors and the emergence of tenerals within the field may lead to overlapping of breeding cohorts. Several carabids survive more than one generation as adults with the ability to reproduce in successive seasons (Luff, 1973). The phenology of *P. melanarius* makes it unlikely that the extended margins were used for overwintering. However, data from directional gutter-trapping experiments suggest that dispersal of sub-populations may occur throughout the field season (Kielty, unpublished). Frequently observed localised dispersals between margin and crop may be in response to density-dependent factors such as over-crowding and prey availability, or as aggregative responses to prey density and more favourable micro-climatic conditions. Such behaviour may increase the survival rate and hence biocontrol potential of predators.

Table 1: The mean density (shoots $100cm^{-2}$) of couch-grass, mean light intensity at the soil surface, mean micro-climate data and the corresponding pitfall trap catch of Carabidae, with special reference to the activity density of *Pterostichus melanarius*.

	25m from the hedge base				45m from the hedge base				65m from the hedge base			
	1	2	3	4	1	2	3	4	1	2	3	4
Weed Densities	0.35	0.95	0.30	0.20	17.0	0.42	3.50	0.25	0.25	0.60	5.95	10.45
Light Intensity ($x10^3$)	12.15	5.70	10.275	6.00	3.975	4.85	10.35	11.50	9.55	11.25	12.00	4.075
Total Carabidae	40	100	59	94	119	104	61	66	57	69	64	128
Night-time *P. melanarius*	19	58	27	65	52	62	33	26	37	38	52	61
Day-time *P. melanarius*	4	31	8	19	29	23	5	11	4	9	6	42
Mean Relative Humidity (%)	-	-	-	-	-	-	-	-	92.0	98.0	(-)*	95.0
Mean Soil Temperature (°C)	-	-	-	-	-	-	-	-	17.3	17.2	16.2	16.6
Mean Air Temp. (Soil surface)	-	-	-	-	-	-	-	-	17.8	16.95	16.7	16.0
Mean Air Temp. (30cm)	-	-	-	-	-	-	-	-	18.0	17.7	17.3	15.8

* = absent figure due to equipment malfunction

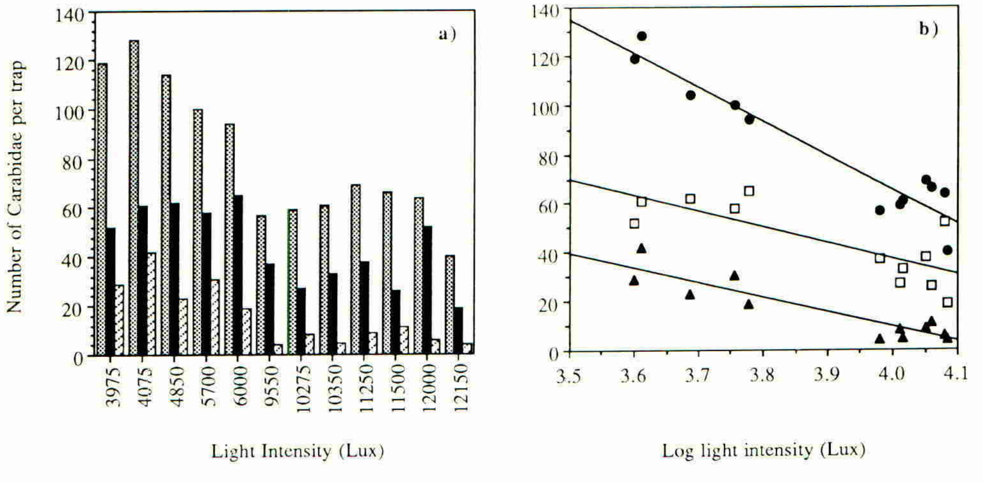

Figure 2. Pitfall trap catch as a function of day-time light intensity at the soil surface: a) the total number Carabidae (▩), the number of *P. melanarius* caught at night (■) and the number caught during the day (▨) per pitfall trap; b) regression analysis on the total number of Carabidae (●), the number of *P. melanarius* caught at night (□) and the number caught during the day (▲). ($P<0.001$ on total catch, $P<0.01$ on day-time and $P<0.05$ on night-time catch).

For species with summer larvae, such as *Pterostichus cupreus*, the margins may provide suitable aestivation sites for beetles which over-winter as adults. The number of *P. cupreus* adults (an important predator of the cereal aphid *Rhopalosiphum padi* in spring barley in Sweden [Chiverton, 1987 and 1988]) caught in the spring increased over the study period. In the absence of spring breeders known to be efficient natural enemies of aphids, such as *Agonum dorsale* the importance of *P. cupreus* and second generation *P. melanarius* should not be underestimated. The potential of the Lycosidae to limit aphid populations was reported by Nyffeler & Benz (1988). However, field penetration by wolf spiders was limited and, hence, the biocontrol potential of these organisms was reduced, though extended field margins may provide more suitable conditions for survival than the cultivated area.

The presence of weeds in arable crops may increase the activity density of some Carabidae, despite having been shown to hinder the movements of some larger species (Greenslade, 1964). However, observations of couch-grass structure at the soil surface and carabid movement therein suggest that this weed does not provide a barrier to movement or reduce activity (Kielty, unpublished). At site A in 1991 Carabidae activity density was greater in weedy than less-weedy areas. Pitfall trap catch, especially during daylight, was correlated with light intensity at the soil surface. Where light penetration was reduced with and without weeds the catch of *P. melanarius* was significantly higher. Previous studies have shown that weeds enhance insect diversity (Potts & Vickerman, 1974) and density by provision of shelter, suitable micro-climate and alternative prey for polyphagous species (Speight & Lawton, 1976; Powell *et al*, 1985; Chiverton & Sotherton, 1991).

Set-aside field margins, if managed with due consideration for beneficial insects, may have the ability to enhance populations of Carabidae by providing not only over-wintering sites for adult hibernators but also 'all-season-long' refugia.

ACKNOWLEDGEMENTS

The authors wish to thank Mr. R. Sherriff, Hall Farm, Bayford, Herts. and Mr. G. Lawrie of The Hertfordshire College of Agriculture & Horticulture for the provision of field study sites and Dr. W. Powell of the AFRC Institute of Arable Crops Research, Rothamsted for helpful advice.

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THE VALUE OF SET-ASIDE TO BIRDS

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ABSTRACT

This study aims to assess the value of set-aside and Countryside Premium Scheme (CPS) management for farmland birds through surveys of fields and margins on 31 commercial farms in southern and eastern England. Fields of set-aside permanent fallow and CPS meadowland and wildlife fallow have been compared with fields remaining in arable production, and hedgerows managed under the wooded margin option have been compared with those adjacent to set-aside and arable land. Factors likely to affect bird numbers, other than those influenced by management, were partly controlled for in experimental design. Birds using selected fields and margins were surveyed in April-July 1990. The same fields and margins have been re-surveyed in 1992 to assess changes over time in relation to management. This paper presents results from the initial comparisons. It is hoped that preliminary results from the second survey can be presented at the symposium.

INTRODUCTION

Whilst recognising that the primary aim of the existing 5-year set-aside scheme is to reduce agricultural production, the RSPB believes that the scheme can be tailored to benefit wildlife. This approach has been adopted in the pilot Countryside Premium Scheme, introduced by the Countryside Commission (CoCo) into 7 eastern counties in June 1989. CPS provides incentives for positive management of set-aside land for the benefit of wildlife, the landscape and the local community (see CPS management guidelines). At the time that the CPS management prescriptions were being devised, the RSPB provided Co Co with advice on the habitat requirements of several declining bird species and the management practices which could benefit them.

The objectives of this study are to assess the value of set-aside and CPS management for farmland birds through surveys of fields and margins on 31 commercial farms in southern and eastern England. CPS land is being surveyed under sub-contract to Land Use Consultants contracted by the Countryside Commission to evaluate the Scheme as a whole.

Fields of set-aside permanent fallow and CPS meadowland and wildlife fallow have been compared with fields remaining in arable production. Field margins adjacent to set-aside land and those managed under the CPS wooded margin option have been compared with margins adjacent to arable land. The first survey commenced in spring 1990. A repeat survey will have been completed by the time of the symposium. This paper presents the initial baseline results. Results from the second survey may be presented at the symposium.

METHODS

Study areas and farm selection

Eleven farms in southern England (Dorset, W.Sussex, Wilts., Bucks., Gloucs.) and 20 farms in eastern England (Essex, N'folk, S'folk, Cambs., Beds., Herts.) were selected for the survey. Preference was given to farms with some land remaining in arable production to enable direct comparison within farms. Ten of the southern farms were in the set-aside scheme in 1990 and one was wholly arable. Five farms in the eastern region were in set-aside only and 15 were in CPS or a combination of CPS and set-aside. Where between-farm comparisons had to be made the farms were matched by location, soil type, farm type (arable or mixed) and crop types. Several farms where habitats such as woodland, rivers and wetland would have influenced bird numbers and composition, were excluded from the selection

Margin selection

Existing hedgerows managed under the CPS wooded margin option (with and without new planting) and hedges with set-aside land on both sides are compared with those with arable land on both sides. Margins were initially matched for factors known to influence bird numbers, such as hedge height and width, number of shrub species and average tree density (Green & Sears, in prep). Margins adjoining woodland have been excluded due to the large and variable influence of woodland type on bird numbers and composition.

Field selection

Fields of CPS meadowland and wildlife fallow and set-aside permanent fallow are compared with fields which remained in arable production in 1990. Factors likely to affect bird numbers, other than those influenced by management, were partly controlled for in the initial selection. Fields were matched by farm type (mixed or arable), soil type and cropping history (matching the last crop grown on set-aside or CPS land with the same type of current crop). Matching of other habitat factors was tested statistically through principle components analysis and regression.

Survey methods

Birds using the selected fields and margins were surveyed twice between April and July 1990 using 50m transect sections of margins and zig-zag transects of whole fields. All adult birds, breeding and non-breeding were recorded.

The following field margin habitat variables were measured for each margin section; hedge dimensions, number of shrub species, number of mature trees, dominant flora of hedge, hedge base and margin. Field habitat variables recorded included soil type, field area, cropping history and set-aside cutting regime. Vegetation structure and dominant species were recorded in 10 quadrat samples per field.

RESULTS

Field margins

Set-aside compared with arable

Field margins adjacent to arable and set-aside were reasonably well matched for those habitat variables considered likely to be important to birds (South; n=54 arable and 51 set-aside sections. East; n=46 arable and 23 set-aside sections). For 15 bird species analysed, there was little difference in the number of birds per section or the proportion of sections with birds present, although Dunnock showed a significant preference for set-aside margins in the southern region and significantly more Woodpigeon were recorded in set-aside than arable sections in the eastern region.

Wooded margins compared with arable

Wooded margins with new planting (n= 63 sections) and without it (n=60 sections) were not well matched with arable margins, but it was possible to control for variation in factors influencing birds by comparing regressions. There were no marked differences in bird numbers (all species combined) in relation to hedge shape for either type of wooded margin compared with arable. Four species were recorded in a significantly higher proportion of wooded margin than arable margin sections; Linnet, Whitethroat, Red-legged Partridge and Woodpigeon. The first three species are of conservation interest. House Sparrow was recorded in significantly more arable sections.

Fields

Set-aside compared with arable

There were three times as many birds per hectare and a larger number of species recorded using set-aside fields than arable fields in both regions (Table 1). In the eastern region, 31 out of 33 bird species analysed were recorded in a higher proportion of set-aside fields of which 10 were significant. In the southern region 14 out of 24 species were recorded in a higher proportion of set-aside fields and 5 were significant. Overall, 12 species showed a significant preference for permanent fallow fields and only three preferred arable (Table 1).

TABLE 1 Comparison of permanent fallow set-aside and arable

	South		East	
	Arable	Set-aside	Arable	Set-aside
No. of fields	56	69	53	50
Total area (ha)	543.7	543.1	265.5	327.5
Median field size (ha)	9.0	7.3	6.8	5.9
Median no birds/ha	1.13	3.62	1.04	3.24
Number of species	22	27	28	40

Species recorded in a significantly higher proportion of fields

Permanent fallow>arable	arable>permanent fallow
Buzzard	Chaffinch
Goldfinch	House sparrow
Grey partridge	Pheasant
Linnet	
Magpie	
Mistle thrush	
Red-legged Partridge	
Rook	
Skylark	
Starling	
Stock dove	
Woodpigeon	

<u>Meadowland and wildlife fallow compared with arable</u>

Similar results were obtained in the comparison of meadowland and wildlife fallow with arable, where the number of birds per hectare was more than twice as high for both meadowland and wildlife fallow (Table 2). 23 out of 34 species analysed were recorded in a higher proportion of meadowland fields and differences were significant for ten species. 18 out of 34 species were recorded in a higher proportion of wildlife fallow fields of which 8 were significant (Table 2).

TABLE 2. Comparison between CPS land and arable

	Arable	Meadowland	Wildlife fallow
No. of fields	53	26	25
Total area (ha)	265.5	124.8	222.9
Median field size (ha)	6.8	4.1	5.4
Median no birds/ha	1.04	2.30	2.71
Number of species	28	27	24

Species recorded in a significantly higher proportion of fields

Meadowland>arable	Arable>meadowland
House martin	Lapwing
Linnet	Pheasant
Mistle thrush	
Red-legged partridge	
Reed bunting	
Sedge warbler	
Starling	
Whitethroat	
Woodpigeon	
Yellow wagtail	

Species recorded in a significantly higher proportion of fields	
Wildlife fallow>arable	Arable>wildlife fallow
Grey partridge	Blackbird
Jackdaw	
Mallard	
Mistle thrush	
Red-legged partridge	
Skylark	
Stock dove	
Yellow wagtail	

DISCUSSION

It must be stressed that this first survey has only provided preliminary results for comparison with future surveys. The CPS land was in its first year of management in 1990 with recently planted trees and newly sown meadows. The second survey in 1992 should give a clearer indication of the benefits of meadowland and wildlife fallow management.

It is not surprising that there were few differences in bird numbers between margin types, given that samples of field margins were initially matched for habitat variables known to influence birds. Variables such as hedge dimensions and flora may change as a result of the different management regimes. By re-surveying the same margins it should be possible to measure changes in bird numbers in relation to management.

Several bird species of high conservation interest were recorded using set-aside and CPS land in preference to arable. The Grey Partridge is a priority species for conservation action in Britain (Batten *et al.* 1990). Its population has declined dramatically since the 1950s, largely due to the use of pesticides on cereal fields. Use of pesticide-free set-aside and wildlife fallow may help reverse the downward trend. Notable species recorded using meadowland include Linnet, Red-legged Partridge, Sedge Warbler, Whitethroat and Yellow Wagtail. These are all species which deserve attention since they may not be able to maintain their range or numbers over the next 25 years (Batten *et al.*).

The RSPB is studying several farmland bird species of high conservation priority which may benefit from management of set-aside land. Only 160 pairs of Stone-curlews breed in England. They have been recorded nesting on permanent fallow set-aside in two years; two pairs in East Anglia in 1989 and one pair in Wessex in 1991. It is likely that ordinary set-aside becomes too densely vegetated after its first year and that special management, such as the wildlife fallow option of the CPS, is required to favour Stone-curlews. The Cirl Bunting is another farmland bird species of high conservation priority. During the winter of 1989/90 a high proportion of the wintering population in Devon was recorded feeding on cereal stubbles, including two fields of rotational fallow. The following summer there was an increase in the number of pairs nesting in adjacent hedgerows and more set-aside stubble fields were used in successive winters.

ACKNOWLEDGEMENTS

This study would not have been possible without the co-operation of all the landowners and tenants to whom we are very grateful. The field surveyors in 1990, Andrew Malkinson, Nicholas Milton and Richard Stone worked long hours to collect the data. The CPS study was part funded by CoCo through LUC.

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INVERTEBRATE ABUNDANCE ON CEREAL FIELDS AND SET-ASIDE LAND: IMPLICATIONS FOR WILD GAMEBIRD CHICKS

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ABSTRACT

During June and July 1990 and 1991, insect samples were taken from several farms in Southern England. Fields in three land-management categories were sampled: fields that had entered the U.K's five-year set-aside scheme for the first time following a cereal crop in the previous year, fields in the second year of the scheme and fields in winter wheat. On each farm, samples were taken from winter wheat and one type of set-aside each year, within the headland area using a vacuum suction sampler.

Of the 12 invertebrate groups studied, most showed significant differences between the treatments. The Diptera, most Coleoptera, Symphyta and Aphididae were most abundant in wheat, whereas numbers of Collembola, and especially Heteroptera and Auchenorrhyncha were highest on set-aside. Many of these groups are eaten by gamebird chicks, which require an insect-rich diet to survive. The abundance of chick food items was three times as high on set-aside than on cereals. when translated into chick survival rates, it spelt the difference between a declining partridge population (wheat) and an increasing one (set-aside).

INTRODUCTION

The grey partridge (*Perdix perdix*) was once a common bird of arable land in Britain, which has declined from 25 pairs/km^2 in the early 1950s to less than five pairs by the mid 1980s (Potts, 1986). One of the reasons for the decline is a drop in the chick survival rate. To survive, young chicks require a diet rich in insects, which they glean from cereals and associated weeds (Potts, 1986; Green, 1984). While most insects are potential food items, three groups are of particular importance to chicks: Heteroptera (especially Miridae), sawfly larvae (Hymenoptera: Symphyta: Tenthredinidae) and Coleoptera (especially Chrysomelidae, Curculionidae and Carabidae) (Sotherton & Moreby, in press).

The cereal ecosystem, when properly managed, can be a food-rich environment suitable for young gamebird chicks and many other farmland birds (Sotherton, 1991). The conversion of arable land to set-aside poses the question whether it will provide similar brood-rearing habitat, in terms of structure and chick-food insects. A five-year study began in 1990 to look at changes in the flora and fauna found in the headlands of fields entered into the UK's five-year Set-aside Scheme. Fields were either left fallow after harvest, or drilled with perennial rye-grass as a ground cover. Both types were compared with fields of winter wheat.

This paper presents some initial results for invertebrates in first and second year naturally regenerating fallow set-aside compared with winter wheat fields, and discusses the implications for gamebird chick survival.

METHODS

In late June-early July 1990 and 1991, 44 fields of winter wheat and ones in their first year of set-aside were sampled on five farms in Hampshire and Wiltshire. In 1991, 15 fields on two of the farms visited in the previous year were again sampled to evaluate set-aside left fallow for a second year.

Insects were collected using a D-Vac insect suction sampler (Dietrick, 1961) in the headlands of the fields, approximately 3m from the field edge. Five samples, each covering 0.5 m^2, were taken at each site. The samples were frozen within a couple of hours and later stored in 90% alcohol. Insects were counted and identified to species or to family. Differences between treatments were analysed using ANOVA, after log(n+1) transformation of the data. First- and second-year set-aside fields were pooled if there was no significant difference between the two year classes; If significantly different, the two types were treated separately. Owing to the large number of comparisons, differences were accepted only at significance levels lower than 1%.

The sampling regime, a one-off collection in each field, meant that any within-season changes in the fauna would not be detected. However, the primary aim was to compare the food available to partridge and pheasant chicks at times of peak chick hatch, when broods were actively foraging for arthropods. On each farm all fields were sampled within a 1-3 hour period each day, the D-Vac collecting arthropods from all levels within the vegetation and from the crop floor.

While the flora of the different fields sampled varied both within and between farms and these changes in species composition and percentage cover will have had an effect on the arthropod fauna, these data will not be presented in this paper.

RESULTS

Three groups, the Araneae, Collembola and the caterpillar-like larvae of the Lepidoptera and Symphyta, showed no significant differences between the numbers found in cereal and fallow set-aside fields (Table 1).

On average, over 75% of the Heteroptera belonged to the family Miridae. On first-year fallow set-aside, no differences in abundance of Heteroptera were found compared to the cereal crop. However, four times as many Heteroptera were found in the second-year set-aside than in the cereal (Table 1). Species composition on the second-year fallow resembled that normally found in the field boundary rather than the field itself. The species found included both specialist grass-feeders, such as *Amblytylus nasutus* and *Stenodema* spp. and more generalist species such as *Plagiognathus chrysanthemi* and *Lygus* spp. In both years the polyphagous feeder *Calocoris norvegicus* was found in higher numbers in the cereal compared to the set-aside fields, however the numbers were low compared to other experimental sites sampled over the two years (Moreby unpub. data).

The numbers of aphids found in the study were generally low, however over twice the number occurred in the wheat crops compared to the set-aside.

The other Homopteran group studied, the Auchenorrhyncha, (plant hoppers such as Cicadellidae and Delphacidae), was six times more abundant on the set-aside than in the cereal.

Three of the four Coleopteran groups studied, the Carabidae, Staphylinidae and Chrysomelidae, were found in significantly higher numbers in cereals than in the set-aside. In some years the chrysomelid *Oulema melanopa* which feeds on cereals can occur at densities far exceeding the value for total chrysomelids of 1.7 per m^2 found during the study, in which case they can be an important chick-food item. The fourth beetle family, the Curculionidae, was also found in low numbers, with more on first than on second-year set-aside. Members of this family, (particularly *Sitona* spp.), were once common in cereals undersown with a legume mixture (Potts & Vickerman, 1974), and set-aside fields where legumes occur naturally or are sown may favour this group.

The final insect group, the Diptera, occurred in significantly higher numbers in cereals than in either year-class of set-aside. The importance of this group to chicks is difficult to assess as little of their soft bodies remain in faecal samples, the main method of determining the diet of gamebirds chicks (Moreby, 1988).

The Auchenorrhyncha and Heteroptera are two of the important groups in the pooled category of "total chick-food insects", the other groups being the Carabidae, Chrysomelidae and Curculionidae and Lepidopteran caterpillars and Symphyta larvae. The significantly higher numbers of total chick-food items found on the set-aside was greatly influenced by the significant differences shown by the first two groups.

DISCUSSION

In grasslands the Auchenorrhyncha are found 'stratified' within the vegetation layers (Payne, 1981; Novotny, 1992) and this probably explains the surprisingly high numbers found in the set-aside. A simple cereal monoculture does not seem to be as suitable for hoppers, which prefer a more complex habitat structure. Hopper species probably occurred at varying preferred heights within the vegetation of the set-aside, including some above the chick feeding height. However, their relative abundance could still mean many would be available for chicks.

During the two study years the numbers of another important chick-food group, the sawfly larvae, were very low. Symphyta populations are thought to cycle through delayed density dependence (Potts, 1977; Aebischer, 1990) and in some years, larvae are relatively common in cereals crops. Most species feed on Gramineae, including cereal and rye-grass crops. It is unlikely that the high numbers found on these Graminaceous monocultures would occur on set-aside unless a good cover of cereal volunteers or grassy host plants was present, or unless the previous cereal crop was under-sown.

In this study greater densities of total chick-food insects were found on fallow set-aside of either age class than on cereal fields. These differences were heavily weighted by the high numbers of Auchenorrhyncha found on set-aside. If these were removed, the remaining insect groups selected by chicks were generally more numerous in cereals than in first-year set-aside. In second-year set-aside, the increase in Heteroptera led to an overall greater abundance of these groups in set-aside than in cereals. Mature fallow set-aside could be expected to have a greater species diversity in both fauna and flora than cereal monocultures, and could often contain greater numbers of potential chick-food items.

TABLE 1. Mean density (0.5m^{-2}) (± one standard error) of invertebrate taxa sampled from fallow set-aside fields or fields of winter wheat, Southern England, June-July 1990,1991.(Set-side is split into first-year and second-year when the differences between the two types were significant).

		No. of field (n)	Mean density (± one s.e.)	t	(df)	P
<u>Chick-food Groups</u>						
Heteroptera	WW	14	7.0 ± 2.5	0.90	(49)	NS
	SA1	30	7.0 ± 1.8			
	WW	7	6.2 ± 2.0	3.90	(49)	<0.001
	SA2	8	23.8 ± 1.2			
Hemiptera - Auchenorrhyncha	WW	21	8.8 ± 1.6	6.55	(50)	<0.001
	SA	38	53.0 ± 18.9			
Lepidoptera/ Sawfly larvae	WW	21	0.7 ± 0.2	1.34	(50)	NS
	SA	38	0.4 ± 0.1			
Coleoptera - Carabidae	WW	21	0.8 ± 0.2	5.28	(50)	<0.001
	SA	38	0.3 ± 0.1			
Coleoptera - Staphylinidae	WW	21	13.5 ± 3.5	3.82	(50)	<0.001
	SA	38	5.6 ± 2.0			
Coleoptera - Chrysomelidae	WW	21	1.4 ± 0.3	4.31	(50)	<0.001
	SA	38	0.7 ± 0.4			
Coleoptera - Curculionidae	WW	14	0.2 ± 0.1	2.76	(49)	<0.01
	SA1	30	1.5 ± 0.8			
	WW	7	0.8 ± 0.1	0.89	(49)	NS
	SA2	8	0.4 ± 0.1			
Total Chick-food Items	WW	21	18.7 ± 2.09	5.40	(50)	0.001
	SA	38	66.9 ± 21.16			
<u>Other Groups</u>						
Hemiptera - Aphididae	WW	21	74.3 ± 23.3	3.43	(50)	<0.01
	SA	38	30.9 ± 11.5			
Collembola	WW	21	661.5 ± 161.9	0.82	(50)	NS
	SA	38	855.2 ± 162.9			
Diptera	WW	21	67.1 ± 18.8	3.04	(50)	<0.01
	SA	38	37.6 ± 5.3			
Araneae	WW	21	10.4 ± 1.6	0.42	(50)	NS
	SA	38	13.0 ± 2.8			

Symphyta larvae = Hymenoptera: Symphyta: Tenthredinidae.
WW = Winter Wheat
SA = Set-aside (pooled)
SA1 = Set-aside (1st year), SA2 = Set-aside (2nd year)

Based on the densities of insects found in this study (Table 1), a multiple regression equation relating partridge chick survival to invertebrate densities sampled in an identical fashion in Sussex (Potts & Aebischer, 1991), predicted an average chick survival rate of 25% in winter wheat and 32% in set-aside. As a chick survival rate of 30% is needed for partridges to maintain themselves (Potts, 1986), the long-term population trend would be downward in cereals and slowly increasing in fallow set-aside.

This study has examined only one aspect, chick-food abundance in assessing the value of fallow set-aside as game-rearing habitat. Whether the vegetative composition and structure of set-aside is suitable for chicks, giving adequate cover and allowing easy movement, as well being insect-rich has yet to be adequately addressed. In many of the set-aside fields sampled, the vegetation was probably too dense at the base to allow chicks to forage, especially in wet weather, when the vegetation could remain wet at this level for long periods. Lodging due to heavy rain could further restrict movement.

Another topic worth investigation is the value of sown set-aside to re-create brood-rearing habitat that mimics the qualities of cereal crops. Insect host plants can be sown and their structure and canopy altered by drill width and choice of species (Sotherton & Boatman, this volume). Set-aside land could provide valuable brood-rearing areas if properly managed from a basis of sound research.

ACKNOWLEDGEMENTS

We would like to thank Sue Southway for her help in the collection and sorting of the samples. We are grateful to the many farmers who allowed us access to their set-aside and cereal fields and colleagues for their helpful comments on earlier drafts of this paper.

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BRENT GEESE: A CONFLICT BETWEEN CONSERVATION AND AGRICULTURE

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ABSTRACT

This paper investigates the viability of establishing Alternative Feeding Areas (AFAs) for brent geese as a means of reducing conflict between conservation of this species and agriculture. The success of the 'Countryside Premium' scheme for set aside land, as a means of creating AFAs, is assessed and a method for monitoring such schemes developed. Fifty percent of sites entered into the scheme in 1989-90 supported geese by the second year. The most important factor determining the use of sites by geese was the height of the grass sward. The results of a series of pasture managements experiments show that maintaining a short sward is the important factor and the details as to whether it is managed by grazing, cutting or a combination of these is less important.

INTRODUCTION

The world population of the dark-bellied brent geese *Branta bernicla* has increased dramatically in the last 40 years from approximately 15,000 in 1950s to a current estimated world population of over 200,000 (Owen 1990). This increase is due mainly to a reduction in the shooting mortality (Ebbinge, 1990) and a series of highly successful breeding seasons in 1970s (Owen, 1990). Almost half the world population of dark-bellied brent geese, which breed in the Taimyr Peninsula in Siberia, over-winter in Britain, largely around the south-east coast of England. In the past the birds fed exclusively on intertidal mudflats and salt marsh, but since the 1970s they have been observed in large numbers feeding inland on grass pastures and arable crops. Their grazing on arable crops such as winter wheat can cause losses in yield of around 6-10% (Summers, 1990). As a result this species has come to be viewed by some farmers as a serious agricultural pest.

There are a number of possible solutions to the problem: co-ordinated culling of geese; compensation for farmers sustaining crop damage or the provision of Alternative Feeding Areas (AFAs) (Owen, 1990). The latter involves managing areas of grassland where brent geese can graze undisturbed if scared from nearby arable fields. The 'Countryside Premium' for set aside land is one scheme providing incentives to farmers to create winter grazing areas for brent geese ('Brent Geese Pasture' option, Countryside Commission, 1991). This paper considers the viability of establishing AFAs as a means of reducing damage to arable crops by brent geese.

The paper is in three sections. First we present the results of work carried out to develop a quick, easy but fairly accurate means of determining the extent to which geese use areas of grass pasture. An application of the survey method developed is considered in section two in which we present results of a survey, undertaken by the Countryside Commission in 1992, of all 'Brent Goose Pasture' sites entered into the Countryside Premium scheme in 1989-90. Data are presented on grazing intensities of geese in relation to a number of site characteristics. The success of the scheme in terms of the intensity of goose grazing on the sites and the effectiveness of the management guidelines are discussed. The paper then summarises results from three pasture management experiments, undertaken as part of a wider study of the feeding ecology of brent geese. Differences in grazing intensity of geese on areas of grass pastures managed under different cutting, grazing and fertiliser regimes are considered, and the most appropriate management regimes discussed.

1. ASSESSING THE GRAZING INTENSITY OF BRENT GEESE ON GRASS PASTURE.

The extent to which an area is grazed by geese is frequently assessed from dropping densities. Geese defaecate at intervals of 3 to 4 minutes so the density of droppings provides a good index of grazing intensity (Owen, 1971). The aim of the present study was to develop a practical and financially viable method of assessing the grazing intensity of brent geese on a number of different areas of grass pasture. Dropping densities are easily assessed, but it was necessary to determine whether the density recorded on one visit could be used to estimate the total grazing intensity over the entire winter and if so the time at which the visit should be made.

In the winter of 1990-91 the grazing intensity of brent geese on 40 grass fields on the North Norfolk coast (Norton and Overy Marshes, National Grid Reference TF830445 and TF855445 respectively) was assessed from dropping densities in each field. Twenty-five canes were positioned randomly within each field and the droppings within 1.5m of these canes were counted and cleared at four week intervals from mid-November to mid-March. The relationship between the cumulative dropping density over the entire winter and the dropping density recorded in each individual month was examined. The density of droppings in January provided the most accurate indication of cumulative dropping density. The relationship was highly significant ($F_{1,38}$=60.07 p>0.0001, Fig.1) suggesting that the winter grazing intensity of geese could be assessed from the density of droppings recorded on a single visit made in January.

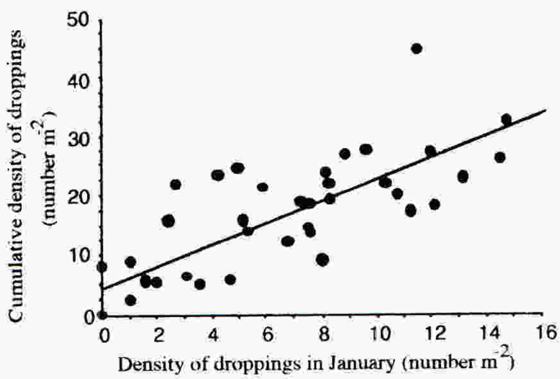

FIGURE 1. The relationship between the cumulative density of droppings (November to March) and the density of droppings in January on plots cleared one month previously. Each point represents one field, r^2=0.62, p<0.0001

In Figure 1 the density of droppings was recorded on plots where droppings had been counted and cleared at monthly intervals, thus the density of droppings in January was recorded on plots that had been cleared one month previously. To use the density of droppings recorded on one visit to provide an index of winter grazing, the relationship between the dropping density recorded once, from previously uncleared plots, and the cumulative dropping density at the same site was determined. Thirty sample plots were set randomly over three fields at Norton Marshes, each plot comprising two canes set approximately 7m apart. At one cane droppings were counted and cleared at monthly intervals following the procedure outlined above. Since 88% of droppings survive over four weeks, counting droppings at monthly intervals was considered to provide a good estimate of total grazing intensity (Vickery & Summers, 1992). At the second cane in each plot droppings were counted on a single visit on 3rd March. Ideally the single visit should have been made in January, however the use of these fields was relatively constant throughout the winter, with mean cumulative dropping densities of 5.93, 6.10, 5.83

and 5.87 droppings m^{-2} recorded in each of the months of November, December, January and February respectively. A single sample in early March rather than January is not likely to have resulted in any significant inaccuracies in calculating the relationship between the dropping density on a single visit and the total dropping density. The relationship was highly significant ($F_{1,28}$=22.58, r^2=0.45, p<0.001) and can be used to calculate the total dropping density:

'cumulative no. droppings m^{-2} = 1.28 (no. droppings m^{-2} in January) + 32.61'

The relationship is only valid for used sites where dropping densities are between 2 and 30 droppings m^{-2} (sites not grazed by January are assumed to support no geese over the winter). Assuming that geese feeding on grass defaecate at a rate of one dropping every 3.4 minutes (Summers & Critchley, 1990), the cumulative dropping density can be converted to 'minutes of goose grazing'. Thus the intensity of grazing, in terms goose minutes m^{-2} on a site over the winter, can be calculated from the dropping density recorded on the site in January.

2. THE SUCCESS OF BRENT GOOSE COUNTRYSIDE PREMIUM SITES IN BRITAIN.

All sites entered in 1989-90 into the 'Brent Geese Pasture' option, under the 'Countryside Premium' scheme were surveyed in January 1992 for the Countryside Commission. At each site 25 canes were placed randomly in each field and droppings counted within a radius of 1.5m around each cane. The height of the sward is known to be an important factor in determining field choice in brent geese and at five of the 25 canes the sward height was measured to the nearest 0.5cm using a sward stick: a sliding polystyrene disc (diameter 24cm and mass 28.5g) on a graduated stick the end of which rested on the ground (Summers & Critchley, 1990). The distance of the site from the nearest house (a measure of disturbance) and from the roost site of the brent geese were assessed from 1: 50 000 Ordnance Survey maps.

A total of 12 Countryside Premium sites under the Brent Geese Pasture option were surveyed in winter 1991-92; eight in Essex, three in Suffolk and one in Norfolk, representing an area of 346 hectares. Fifty percent of the sites were used by geese; four in Essex, one in Suffolk and one in Norfolk. Most sites comprised a number of fields that differed in their geographical location (in relation to roost sites and houses) and in sward height and were therefore considered separately in the analyses.

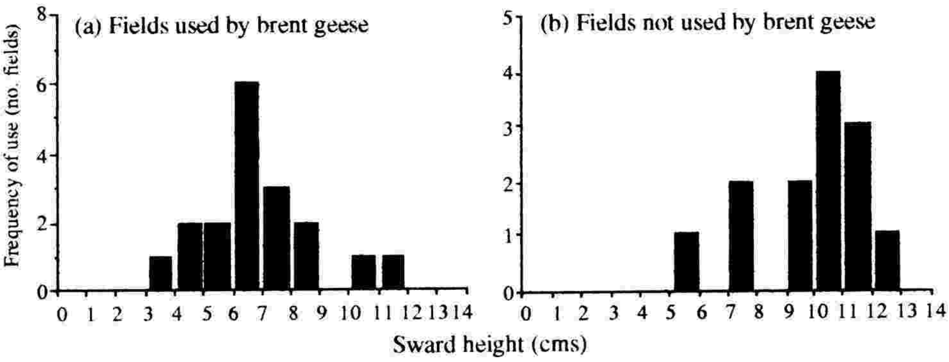

FIGURE 2. The frequency of use of 'Countryside Premium sites' of different sward height. Individual fields within sites are considered separately: used fields n=18, unused fields n=13.

Approximately half the individual fields (n=31) were used by geese (58.1%). There was a significant difference between grazed and ungrazed sites in the height of the sward (unpaired student t-test, $t=4.42$ $p<0.001$, Fig 2). The mean sward height of fields used by geese was 6.9 ± 0.5 cm (mean ± se, n=18) compared with 10.2 ± 0.5 cm (n=13) at ungrazed sites. There were no significant differences between grazed and ungrazed fields in distance to roost sites or nearest house.

The importance of sward height was further evident from the fact that within grazed sites there was a significant relationship between sward height and the intensity of goose grazing ($F_{1,16}=8.93$ $p<0.01$, Fig. 3). These results suggest that sward height was a key factor determining whether fields were selected by geese and the intensity with which they were grazed. The primary reason why some sites were not grazed by geese was almost certainly that management at these sites did not produce a sward short enough to be attractive to brent geese.

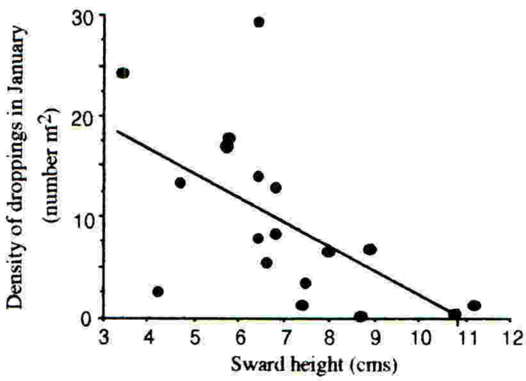

FIGURE 3. The relationship between sward height and dropping density on 'Countryside Premium' sites. Each point represents one site, $r^2=0.36$, $p<0.01$

The mean density of droppings in January on all fields was 5.5 ± 8.0 droppings m^{-2}. This represents 1818 goose grazing days ha^{-1} over the entire winter (based on the relationship given in section one for the 18 used fields, assuming 13 fields were unused and an average of eight hours daylight in the winter). The total area under the scheme was c. 346 hectares and thus approximately 629,028 goose days were supported by 'Countryside Premium Brent Geese Pasture' in winter 1991-92. The mean grazing intensity of geese on sites where the sward height was <6cm in January was 12.4 ± 9.6 droppings m^{-2} (includes 1 unused site) and if the management at all sites had resulted in such swards then the number of goose days supported on Countryside Premium sites would have increased to a total of c. 1,092,282 goose days (2917 days ha^{-1}, over 346 hectares). Furthermore if all sites had been grazed at the maximum level recorded on a Countryside Premium site in 1991-92 (29.3 ± 1.9 droppings m^{-2}) this figure increases to c. 1,718,236 goose days (4966 days ha^{-1}, over 346 hectares). To place this in context, brent geese in north Norfolk feed inland for an average of 133 days. Assuming brent geese wintering elsewhere in Britain feed inland for similar periods of time, with a current British population of c. 110 000 geese (Owen, 1990), this would result in 14,630,000 goose days inland. If the entire population were to feed on Countryside Premium sites at the mean intensities recorded in 1991-92 this would require c. 8047 hectares (c. 2946 hectares if all sites supported geese at the maximum grazing intensity recorded). These figures agree well with an estimate by Summers & Critchley (1990) of c. 5000 hectares of grassland to support the British population of brent geese when feeding inland

The payment per hectare to an individual farmer entering the scheme is £290.00 (set aside payment of £210.00 for permanent fallow plus Countryside Premium of £80.00 for 'Brent Geese Pasture'). Assuming that the geese attracted to the grass fields would have otherwise grazed on arable fields there will be an additional benefit from a reduction in crop damage as a result of establishing an AFA. The figures given in Table 1 suggest that, having entered the scheme, the profitability for an individual farmer is much greater if the site is managed effectively. If the sward is cut to <5 cm in October, as prescribed by the Countryside Premium scheme, the additional benefit to the farmer may be as much as one third the payment.

TABLE 1. The benefits of managing AFAs for brent geese under the 'Countryside Premium' scheme for set-aside land.

Sward Height (Jan)	**>10cm**	**6-10cm**	**<6cm**
No. Goose Days ha^{-1}	431	2274	2598
Yield Loss (winter wheat)	1.9%	10.4%	13.1%
Reduction in Crop Damage ha^{-1}	£15.4	£84.4	£106.6

The number of goose days is the mean for all fields in the three sward height categories >10cm, n=10; 6-10cm, n=15; 6cm, n=6. Yield loss on winter wheat is calculated from regression equations relating dropping density to yield loss (Summers, 1990), assuming a total yield of 7.4t ha^{-1} @ £110.00 t^{-1}.

3. THE MANAGEMENT OF GRASS PASTURE FOR BRENT GEESE.

The attractiveness of grass swards managed under a number of different regimes was investigated as part of a wider study on the feeding ecology of brent geese. Three random-block-design experiments were carried out, in which plots of land were managed over the summer under different cutting, grazing or fertiliser regimes and the grazing intensity of geese determined from dropping densities in subsequent winters.

(i) Experiment one was carried out to determine the cost-effectiveness of the management guidelines for "brent geese pasture" (Countryside Commission, 1991), where the grass sward should be cut three times between June and October to <5cm and fertiliser applied once in late August/September at 50Kg N ha^{-1}. The experiment was carried out between March 1991 and March 1992 on a 20 hectare field at Copt Hall, a National Trust nature reserve in Essex (National Grid Reference TQ955085). The field was seeded in November 1990 with a seed mix of *L. perenne*, *T. repens* and *P. pratense*. The sward was cut at four frequencies: two, three, four and five times and two different fertiliser treatments were used within the cutting treatments: fertilised (Nitram) and unfertilised (control). Each treatment was replicated five times (total number of plots = 40). The plot size was 25m x 100m. Cutting was to <5cm on each occasion and the fertiliser was applied in September at 50Kg N ha^{-1}. The grazing intensity of geese on each plot was assessed from monthly dropping densities in the following winter.

(ii) Experiment two investigated the effectiveness of managing grassland for geese by cutting compared with grazing. The experiment was carried out from March 1990 to March 1992, on 18 hectares of permanent pasture at Old Hall Marshes (National Grid Reference TQ963127), an RSPB Nature Reserve in Essex. Three cutting/grazing treatments were used; cutting for silage, cutting and aftermath grazing with sheep and continuous sheep grazing. Three fertiliser applications were used within each cutting/grazing treatment, applied in late September at 18Kg N ha^{-1}; inorganic (Nitram) or organic base fertiliser (Humber 20) and no fertiliser (control). The plot size was 33m x 75m and each treatment was replicated six times (total number of plots = 54). The grazing intensity of geese was determined, as in experiment one, from dropping densities.

(iii) Experiment three was used to compare swards managed by grazing with either cattle or sheep. The experiment was carried out from March 1991 to March 1992 on 12 hectares of permanent pasture on Northey Island, a National Trust Nature Reserve in Essex (NGR TQ880065). The plot size was one hectare and the two treatments (cattle or sheep grazing) were replicated six times (total number of plots = 12).

The results (Table 2) demonstrate that, in general, there were no differences in the intensity of goose grazing on grass pasture managed under the different cutting or grazing regimes. Dropping densities increased slightly with frequency of cutting and were slightly higher on sheep grazed sites compared with those managed by cutting but these differences were all non-significant. Application of fertiliser at a rate of 50kg N ha^{-1} did, however, significantly increase the attractiveness of the grass sward to geese.

TABLE 2. A summary of the effect of different grassland management regimes on the subsequent winter grazing intensity of brent geese.

Summer management regime	Effect on grazing intensity of geese
Altering the cutting frequency (cutting 2, 3, 4 or 5 times a year)	Grazing intensity increased with cutting frequency (non-significant after 1 year)
Sheep grazing vs. cutting	Grazing intensity higher in sheep grazed areas (non-significant after 2 years)
Sheep vs. cattle grazing	No significant difference after 1 year.
No fertiliser vs. inorganic fertiliser vs. organic base fertiliser (@18Kg Nha^{-1})	No significant differences between fertilised and unfertilised or inorganic and organic base fertiliser.
No Fertiliser vs. inorganic fertiliser (@ 50Kg Nha^{-1})	Grazing intensity significantly higher on fertilised areas

That grazing intensities were high in all three experiments suggests that highly attractive swards for brent geese can result from a range of cutting or grazing regimes. Under the current Countryside Premium scheme grazing is not permitted and the results of these experiments indicate that grassland AFAs for brent geese can be managed equally well by mechanical cutting. Furthermore whilst swards cut five times support more geese than those cut three times (as prescribed in the scheme) the difference was small and unlikely to be cost-effective. In dry summers with little grass growth cutting twice may be adequate. Fertiliser application was beneficial for geese, but not essential, since unfertilised areas were also grazed heavily and other environmental impacts could be minimised by avoiding fertiliser use. As described in section 2 it is essential the final sward is below 6-7 cm and ideally even shorter.

CONCLUSIONS

The most important factor determining whether, and at what intensity, Countryside Premium sites were grazed was sward height. Intensive grazing only occurred on sites where the sward was less than 6-7 cm in January. The policy of ensuring the final sward is less than 5cm in September is ideal since this will allow for regrowth. A series of pasture management experiments suggest that the exact management regime adopted for AFAs may be largely unimportant, as long as the resulting sward is short and green in early winter. Areas grazed with sheep or cattle, cut and aftermath grazed or cut for silage were all used equally intensively by brent geese in the following winter. However, a single application of nitrogen fertiliser did result in significantly higher grazing intensities of geese compared with unfertilised control areas.

A survey of all sites entered into the Countryside Premium for set-aside land in 1989-90 revealed that half the sites were grazed by brent geese in by winter 1991-92 and at grazing intensities that represented considerable potential crop damage had it occurred on arable fields. The value of a site, in terms of the number of geese supported and the associated reduction in crop damage, increased with the effectiveness with which the management produced a short grass sward. Assuming sites are effectively monitored and managed the scheme may provide a cost-effective means of maintaining farmers' incomes whilst allowing for conservation of brent geese alongside current agricultural systems.

ACKNOWLEDGEMENTS

Thanks are due to the National Trust, the Royal Society for the Protection of Birds and L. Sampson for permission to work on their land and for much help during field work, to the Countryside Commission for supplying data concerning 'Countryside Premium' sites, to I. Black for collecting much of this data and to English Nature for funding the research on Northey Island. The authors are grateful to S. Lane for help throughout the project and to R. Knightbridge and A.R.Watkinson for comments on the manuscript. The work was funded by the Agriculture and Food Research Council.

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THE EFFECTS OF SHORT- AND LONG-TERM SET-ASIDE ON CEREAL PESTS

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ABSTRACT

The effects of fallowing on the incidence of cereal pests during and after the fallow are described. Two types of fallowing were studied, long-term and short-term. Pests did not cause significant damage during the long-term fallow, although in some years at some sites cereal volunteers in the fallow were attacked by cereal pests. In some short-term fallow sites slugs and wheat bulb fly were present in sufficient numbers that a crop immediately after the fallow was at risk of significant damage if control measures were not taken. There was, however, no consistent pattern across sites.

INTRODUCTION

The EC set-aside scheme was introduced in the UK in 1988 as a voluntary 5-year scheme. A voluntary 1-year scheme was introduced for one year only in 1991. The main aim of both schemes was to reduce national production as a contribution to the reduction of the EC surplus of grain and other arable crops. Two experiments, funded by MAFF and carried out by ADAS, were set up to examine various effects of short- and long-term fallow as would be experienced under the set-aside schemes (Clarke & Cooper, 1992). This paper reports the observations made during monitoring so far on cereal pests.

METHODS

The design of the experiments and the treatments are given in Clarke & Cooper, 1992. At all sites (Boxworth , Bridgets, Drayton, Gleadthorpe and High Mowthorpe) the crop preceding the trial was wheat.

Long-term fallow

The incidence of cereal pests was monitored during the fallow period and will be continued into the succeeding cereal crop. There are 12 or

13 fallowing treatments, depending on the site, lasting for 3 and 5 years based on ryegrass, ryegrass plus white clover, naturally regenerated vegetation ("tumbledown"), and an arable rotation for comparison. Aphids (usually Sitobion and Rhopalosiphum spp) were assessed in spring each year by counting the numbers on 100 tillers of cereal and/or grass on each plot. Five soil cores (each 50 x 100 mm) were taken from each plot in spring and macro-invertebrates extracted by hand sorting or by heat extractor. In the final year before cropping, cores will also be taken before ploughing or major cultivation and examined for the incidence of Agriotes spp and eggs of Delia coarctata. The major aim of pest monitoring in the cropping years is to prevent pest damage from confounding the effects of other factors. In the cropping years the pest monitoring will be very similar to that used on the short-term fallowing experiment. An assessment of earthworm populations was made at one site in 1990. Two quadrats, one square metre each, were chosen at random in each plot, the vegetation cut short and the soil surface sprayed with 2 litres of 0.2% Formalin each. After 15 minutes worms that had emerged onto the surface were collected and counted.

Short-term fallow

Pest monitoring was directed towards establishing the risk of damage to the succeeding cereal crop. Monitoring concentrated on the period just before the cereal crop was sown after one year of fallow and thereafter during the crop's life. There were three consecutive phases at each site, with four to six treatments in the first phase and four in the second and third phases. After the cropping year of the first phase it was evident that allowing pest attacks as part of the experiment effects was prejudicial to higher priority objectives. The protocol was therefore revised to increase the importance of monitoring to prevent pest attack and reduced action thresholds were imposed. Thus any pest that threatened to cause significant damage to a plot of a trial was treated across the whole trial site for that phase with an appropriate pesticide. During the treatment (fallowing) year, slugs were monitored on the plots sown with Italian ryegrass and those where there was a uncultivated fallow without pesticide treatments. Two baited slug traps were placed in each plot and examined weekly from drilling to GS 14 of wheat volunteers present. In early August, before ploughing, five 50 x 100 or 73 mm soil cores taken from each of the plots sown with Italian ryegrass were dissected to determine the incidence of larvae of Oscinella frit.

The one-year fallow was followed by two crops of winter wheat except at Gleadthorpe. As part of the first cereal year, slug activity was measured, as described above, from ploughing until GS 14 was reached. In mid-September five 100 mm diameter soil cores were taken in each plot to the depth of the cultivation and the incidence of eggs of D. coarctata in them measured (Gough, 1947). From crop emergence until early November 25 plants per plot were examined weekly for the presence of aphids. The incidence of eggs of Opomyza florum and larvae of Tipula spp was assessed by taking five 100 mm diameter cores over the rows per plot. Larvae and eggs were extracted as for D. coarctata. Twenty five plants from each plot were examined for the presence of aphids and shoot-boring larvae (D. coarctata, O. florum, etc) in early March. The incidence of aphids was assessed at GS 61 and again at GS 73 by examining 25 tillers per plot on each occasion. As in the pre-cropping year, an appropriate pesticide treatment was applied if the predetermined threshold for a pest was reached.

In the second cropping year slug activity was monitored, as above, after drilling until GS 14. Aphid incidence was assessed as in the first cropping year in the autumn and summer. Pesticide treatments were applied if necessary, as above. No second year monitoring was done at Gleadthorpe, as the experimental area was drilled with winter barley.

RESULTS

Long-term fallow (5 years)

The first year of the experiment (1989/90, except at Gleadthorpe) was characterised by a low pest incidence with a few exceptions. Aphid levels at the Boxworth site were low, ranging from 0 to 11.3 (mean 2.5) per cent of plants infested in late March. The largest populations were found on plots of the unmanaged naturally regenerated treatment and tended to be larger on plots of the all the natural regeneration treatments than on the other treatments. Populations were generally larger at the High Mowthorpe site, ranging from 0 to 5.8 (mean 2.9) per cent of plants infested. There were no significant differences between treatments and no apparent trend towards a treatment or group of treatments. At Gleadthorpe no aphids were detected in the first year, 1990/91. No monitoring was done during the first year at Drayton.

At the site at Bridgets the grass, and wheat in the arable treatment, had not emerged by the end of the aphids' migration but there were many volunteer wheat plants in the plots (55 - 73 per square m on 12 December). No aphids were detected on grass plants in the autumn examination. By early January 1990 there was an average of 5 aphids per volunteer cereal plants, of which 95 per cent was infested. Thereafter aphid populations declined so that 0.75 per cent of volunteers was infested by early March. No aphids were detected on grass plants then. BYDV (barley yellow dwarf virus) incidence in volunteer wheat was considerable - 58 per cent of volunteers visibly affected in the perennial ryegrass treatment, 57 per cent in ryegrass/clover, 7 per cent in naturally regenerated, 40 per cent in low nitrogen ryegrass and <1 per cent in the winter wheat treatment. It is possible that the presence of a sown grass sward in some treatments could have facilitated the movement of viruliferous aphids on the ground. It is also possible that cultivation reduced the populations of aphid predators that could have inhibited the spread of aphids on the naturally regenerated treatment.

No larvae of *Agriotes* spp and *Tipula* spp (or related species) were detected at Boxworth, Bridgets and Gleadthorpe. At the latter site 1.3 million per hectare of *Bibio* spp larvae were recovered from samples taken from plots of the three-year permanent ryegrass cut at least twice a year. Although there is little information about the effect of these larvae on yield, and no damage threshold level for treatment, they can severely damage wheat (Gair et al, 1987). It is likely that a cereal crop exposed to the level found at Gleadthorpe would suffer significant damage, at least in areas of the crop. No assessment of soil-dwelling macro-invertebrates was made at High Mowthorpe.

A very high level of damage by larvae of Chlorops pumilionis, a local problem, was recorded in volunteer wheat at the Bridgets site. The infestation was estimated at 30 infested volunteers per square m and could, if present in a field at that level, enhance the carry-over of the pest locally. The sown wheat was not significantly attacked, possibly because it emerged after the oviposition period for the pest.

The numbers of earthworms extracted from plots at the Boxworth site were relatively low and very variable. There were no significant differences between treatments but significant differences between blocks. No earthworms were collected in 13 of the 48 plots. Rain fell during the period of the assessment and catches increased greatly after the rain. The assessment was not repeated at other sites or in other years.

In the second year of the experiment pest levels were low at all sites and lower (as were volunteer wheat populations) in most cases than in Year 1. At Boxworth, Bridgets,Drayton and Gleadthorpe no aphids were detected on set-aside treatments. Small numbers of aphids were found at High Mowthorpe on three permanent ryegrass treatments and two naturally regenerated treatments but no significant differences between treatments were found. No larvae of Tipula spp and Agriotes spp were detected at the Boxworth site. Appreciable numbers of Agriotes spp larvae were found in most plots at High Mowthorpe and would probably present a risk of slight injury to most arable crops. There were no statistically significant differences between treatments. Very few Tipula spp larvae were found at this site and few at Bridgets, Gleadthorpe and Drayton, where small numbers of noctuid moth caterpillars, Diplopoda, Oscinella frit larvae and Mesapamea secalis caterpillars were also found. Root aphids (probably Aploneura lentisci) were found in all core samples of grass taken at Drayton. A low level of Bibio larvae (44 per square m) was found in the ryegrass (cut once/year) treatment at Gleadthorpe.

No significant pest damage to the treatments has been seen at any site. The results so far suggest that there is potential for long-term fallow to be a reservoir for some pests but no problems arising from this have been seen on the arable treatment yet.

Short-term fallow

At the end of the fallow treatment year in phase I, the numbers of O. frit larvae ranged from 18 to 290 larvae per square metre where assessed (Bridgets, Gleadthorpe and High Mowthorpe), in all cases below the action threshold. Eggs of D. coarctata tended to be higher on plots of the cultivated fallow treatment but did not warrant treatment except at Boxworth. At this site an estimated population of 7.42 million eggs per hectare was detected on the cultivated plots compared with 1.02 and 1.54 million per hectare on the uncultivated plots. No eggs were detected in any treatment at High Mowthorpe. The samples from the plots of each treatment were pooled for extraction. Slug activity as measured by the baited traps was relatively low at Bridgets, Boxworth and Gleadthorpe. At Drayton more than ten times as many slugs tended to be caught in the ryegrass-sown plots than in the other treatments on the two trapping occasions possible. At High Mowthorpe, on the one trapping occasion possible between ploughing and sowing, 42.9 slugs per trap were caught in the chemical fallow plots, 32.3 in the ryegrass plots, 18.9 in the unfallowed plots and 8.4 in the bare fallow plots. These observations suggest that slug activity/populations tended to be favoured by the retention of green cover during the fallow.

Pest damage in the following wheat crop remained well below economic damage levels at all sites except at Drayton, where significantly more damage by slugs followed the ryegrass treatment. By the end of December the plant stand at Drayton on plots following ryegrass was 38 per cent lower than on plots following the ploughed fallow treatment. This trend was also seen at Boxworth and Bridgets. Very few pests and little damage was recorded at those sites where the second wheat crop after the fallow was monitored, except at Drayton where slugs again posed a threat and a molluscicidal treatment was applied.

At the end of the treatment year of phase II, the numbers of O. frit larvae were low except at Gleadthorpe, where although the mean number (248 larvae per square metre) detected in the ryegrass treatment was below the action threshold the numbers recorded for some plots was above it. The complete trial was sprayed therefore. The numbers of eggs of D. coarctata were below the action threshold at all sites except at Boxworth, where an estimated mean of 7.3 million eggs per hectare was detected in the bare fallow compared with 0.13, 0 and 0 million per hectare in the natural regeneration, arable and ryegrass fallows respectively. At Gleadthorpe egg levels (at 1.25 million eggs per ha) in the weed trim and spring legume plots triggered preventative treatment of the trial. At Drayton the mean numbers of eggs detected per treatment were below the action threshold on all treatments but on one bare fallow plot the threshold was exceeded and a pesticide applied. Relatively low numbers of O. florum eggs were detected at all sites. The numbers of slugs caught were low or very low except at Drayton, where twice as many slugs (4.8 per trap per week) were caught in the ryegrass plots between ploughing and sowing than in the arable plots, and at Gleadthorpe, where 5.5 per trap per week were caught after natural regeneration (with much surface trash) compared with a maximum of 0.25 in the other treatments.

After the wheat crop had been sown, there was a trend for higher numbers of slugs to be caught in plots following natural regeneration. No significant plant damage was recorded at any site in any treatment, including Drayton and Gleadthorpe where the action threshold was exceeded and a molluscicide applied. Attack by D. coactata and other shoot borers was insignificant at all sites except at High Mowthorpe. Here sufficient damage by O. florum was experienced to warrant action, even though few eggs had been detected. Other pests on the wheat crops at the sites were either absent or present at levels too low to warrant action, often at very low levels. Very few pests and little damage were recorded at sites where the second wheat crop after fallow was monitored.

No larvae of O. frit were detected in samples taken at Boxworth and High Mowthorpe at the end of the treatment year of phase III and relatively low numbers found at Bridgets (75 larvae per square metre). An average of 1096 larvae per square metre was found at Gleadthorpe and a preventative treatment advised. A maximum of 89 slugs per week per treatment was caught at Boxworth on the plots following a cereal crop, with 28 in the plots cropped with Italian ryegrass. At Drayton the corresponding catches were 18 and 38, respectively. Control measures were taken at both sites to reduce slug attack to the following wheat.

The numbers of slugs detected at other sites were very low and did warrant action. D. coarctata egg levels were generally low and below the action threshold except at Boxworth, where an estimated population of 3.44 million eggs per hectare was recorded on the bare fallow plots. Treatment was advised.

In the following cereal crop, the number of slugs caught were relatively low and the action threshold was not triggered at any site. No significant damage was seen. Aphids were detected (1% plants infested) at Gleadthorpe and action taken. No aphids were found at other sites and no BYDV was subsequently seen at any site. The numbers of all other pests at all sites were relatively low or absent and no action thresholds were reached. No pest problems have been reported so far at sites where there is a second wheat crop after fallow.

In general, the pest problems experienced so far have been those expected, given the rotations followed, and the results do not suggest that one year set-aside would result in any unusual damage to the next cereal crop from pests. Although a tendancy towards potential damage from a particular pest was seen in some cases, eg, increased slug activity after a green fallow, such trends were not consistent between sites and years. The exception was D. coarctata, which is known to be favoured by the presence of bare soil in the summer (Empson, 1982).

ACKNOWLEDGEMENTS

Financial support for this work from the Ministry of Agriculture, Fisheries and Food (MAFF) is gratefully acknowledged. We thank all our many colleagues who have contributed to this work.

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THE ECOLOGY OF SMALL MAMMALS ON SET-ASIDE AGRICULTURAL LAND.

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INTRODUCTION

This poster describes work carried out as part of a PhD study at Aberdeen University between November 1989 and October 1992. The work is part of an integrated programme at Aberdeen, to study vegetation, invertebrates and small mammals on set-aside land adjacent to semi-natural areas (woodland, bog and rough grassland) within intensively managed farmland.

The project was prompted by the introduction of the Set-aside scheme in October 1988 and is funded by The Joint Agriculture and Environment programme (JAEP).

The aim of the small mammal project was to study small mammal communities found on set-aside fallow land, and look at habitat use of set-aside and adjacent semi-natural and cropped areas.

METHODS

Field work was carried out at two sites: Aberdeen University's Aldroughty farm near Elgin, Morayshire in N.E. Scotland, where the farmland is a mosaic of semi-natural areas adjacent to arable crops and set-aside strips; and farmland in Newburgh, Aberdeenshire, N.E. Scotland, where whole fields have been set-aside.

Population densities and distributions of the small mammals present were determined by live trapping. Radio-telemetry was used to conduct a more detailed study of the habitat preference and home range of wood mice, 33 of which were radiotracked over a period of 12 months.

RESULTS

Four species of small mammal were present in the farm mosaic habitat, The Wood Mouse, Apodemus sylvaticus, the House Mouse, Mus domesticus, the Field vole, Microtus agrestis and the Bank Vole, Clethrionomys glareolus. While at Newburgh, on set-aside, only Wood mice and Field voles were caught.

Wood mice were the most abundant species at both sites, Bank voles and House mice were caught in low numbers. Wood mice populations were present at higher densities on farm mosaic (29/Ha-March'90) than set-aside (8.4/Ha-Sept/Oct'90); while Field voles were similar in density at the two sites.

The weight of male wood mice in the farm mosaic during the breeding season was found to be higher (significantly so for 8 months of the year) than on set-aside at Newburgh.

Wood mice had small home ranges at both sites, during the breeding season, males in the farm mosaic had a mean home range size of 2,537 square meters, and on set-aside 6,838 square meters (100% Minimum Convex Polygon). All home ranges on set-aside were larger than those on farm mosaic, although no significant difference was found.

Data collected from trapping and radio-tracking were used to determine habitat preference of small mammals. It was important to find out whether they used certain habitats within the farm mosaic at Aldroughty more or less frequently than would be expected by chance. The distribution of captures within each trapping grid, home ranges within the study area, and distribution of radio-fixes in each habitat type within the home range was used to determine habitat preference.

Wood mice showed no clear habitat preference, nesting and foraging in all habitat types. There was no seasonal pattern in habitat use, such as movement away from fields during harvest. Voles showed almost exclusive preference for rough grassland, only rarely being caught in set-aside or crop land.

DISCUSSION

Wood mice are habitat generalists, opportunistic animals limited in density and distribution by the amount of food and cover, rather than habitat or vegetation type itself. It appears that the farm mosaic at Aldroughty is a more productive habitat than the set-aside at Newburgh, which can support greater numbers of wood mice, of significantly higher weight and smaller home range size.

Field voles are habitat specialists, dependent on the presence of a specific vegetation structure; thick, dense grass at ground level to build runways. In the farm mosaic at Aldroughty this was present only in semi-natural areas, while at Newburgh the set-aside itself provided suitable cover.

Thus it seems that heterogenaity within habitat types, such as differences between set-aside patches may be more important in determining small mammal species presence, abundance and distribution than broad habitat categories.

STATISTICAL ANALYSIS OF GROUND BEETLE DATA FROM A SET-ASIDE EXPERIMENT

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SUMMARY

The combined use of the multivariate statistical technique, correspondence analysis, and Generalised Linear Modelling was found to generate hypotheses about the data and allow them to be tested.

The activity of ground beetles was found to differ between the various management treatments which were tested in the set-aside experiment.

INTRODUCTION

Set-aside experiments combine features of both agricultural and ecological research methodologies. Agricultural experiments are characterised by a formal structure with treatments applied in a randomised and replicated manner. Ecological studies tend to have a less formal structure but are characterised by large volumes of data arising from multivariate observations repeated in time.

Whereas agricultural experiments are analysed using analysis of variance, ecological data demand the use of multivariate techniques. See James and McCulloch (1991) and Digby and Kempton (1987). In particular, correspondence analysis which is attributed to the French statistician Benzécri (1969) is widely used. Greenacre (1984) has described the technique in English.

MATERIALS AND METHODS

The site and treatment details as well as ground beetle species identified from pitfall trap catches and sampling dates are shown below for 1991.

Site			Treatments			Sampling Dates		Species of ground beetle	
1.	Bush	(U)	1.	Tumbledown, cut 3x, cuttings returned	(b)	19 April	(a)	Pterostichus melanarius	(A)
2.	Boghall	(O)				30 April	(b)	Pterostichus niger	(B)
						14 May	(c)	Pterostichus madidus	(C)
			2.	Sown ryegrass cut 3x, cuttings returned	(e)	28 May	(d)	Pterostichus strenuus	(D)
						11 June	(e)	Calathus fuscipes	(E)
						25 June	(f)	Calathus melanocephalus	(F)
			3.	Sown ryegrass/white clover, cut 3x, cuttings returned	(g)	9 July	(g)	Nebria brevicollis	(G)
						24 July	(h)	Agonum muelleria	(H)
						6 August	(i)	Amara plejeba	(I)
			4.	Sown red fescue, cut 3x, cuttings returned	(j)	20 August	(j)	Bembidion tetracolum	(J)
						3 September	(k)	Lonicera pilicornis	(K)
			5.	Tumbledown fallow, unsown and uncut	(u)	18 September	(l)	Carabus spp.	(L)
						1 October	(m)		
						17 October	(n)		

Footnote: Letters in brackets refer to site, treatment, sampling date and beetle species in Figures 1 and 2.

Similar data were collected in 1990. In 1989 fewer species were separated on a smaller number of sampling dates.

All statistical calculations were carried out in Genstat 5 (Copyright 1990, Lawes Agricultural Trust, Rothamsted Experimental Station). Use of a sophisticated general statistical package easily allows many statistical techniques to be used on the same data set.

Multivariate methods, whilst useful for detecting patterns and thereby suggesting hypotheses, cannot easily be used to test for the effects of applied treatments.

We decided, therefore, to test the feasibility of using correspondence analysis to suggest hypotheses which could then be tested by Generalised Linear Models.

STATISTICAL ANALYSIS AND RESULTS

For 1990 and 1991 data were available for twelve species of ground beetle on fourteen sampling occasions from two sites each with five treatments and five pitfall traps per plot: 8400 items of data per year.

For 1989 less data were available: six species and eight sampling occasions.

The data were probed using correspondence analysis which is a statistical technique for displaying multivariate data in the form of graphs. Correspondence analysis provides an overview of the main features of a voluminous set of data with the objective of isolating these features and analysing them using linear techniques.

The yearly data were simplified to a matrix of 140 rows (date x site x treatment) x number of species by summing over traps. A correspondence analysis was then performed. Supplementary row profiles were calculated for each date and for each site x treatment combination and these graphed together with the species scores.

The graphs for 1991 are given in Figures 1 and 2.

Consecutive dates in Figure 1 have been joined by a straight line. The circular nature of the Figure is evidence of the power of correspondence analysis to summarise systematic features. We note that of the numerically dominant beetle species, A, B, and G: A and B are associated with summer and G with spring/autumn. There is a suggestion from our data that some grouping could occur.

In Figure 2, the treatment x site data have been displayed together with the beetle species information. The same treatments at the two sites are near neighbours on the Figure, except for untreated. The Bush plots are all to the left-hand-side of the Figure in contrast to the Boghall plots which are all to the right-hand-side of the Figure. We interpret these results to mean that there is a systematic effect of site and, more importantly, that the b treatment is apparently different from the u, e and j treatments which in turn are apparently different from the g treatment.

Correspondence analysis has given an overview of the data. Nevertheless the study described is a classical experiment in which treatments are to be compared. Judicious use of the Generalised Linear Model allows the differences between treatments to be modelled and tested.

For illustration, one pattern that deserves further investigation is the treatment differences in the number of species A and B in the mid/late summer periods. For comparison purposes, the treatment differences in the number of species G are also of interest.

Generalised Linear Modelling of the counts of the three numerically dominant species has been carried out. Data from five sampling periods between mid-July and late September have been analysed. A model has been fitted with site, treatment, date and site x treatment interaction. A log link function and

Poisson error variation have been used. An analysis of deviance has been constructed to test the statistical significance of the terms of the model. Predicted values of treatments are given together with standard errors in the Table. By analysing the data for each year separately and displaying the results as in the Table, changes with time can be tested.

Generalised Linear Modelling has allowed the differences between treatments to be tested. Nevertheless, our experience is that the variation may not be fully described by a Poisson error model. Alternative error distributions and link functions should be investigated.

TABLE

Estimated mean numbers (± sem) for three species of ground beetle from the Generalised Linear Model of pitfall trap catch data from two sites and five sampling periods from mid-July to late September.

Treatment

	Tumbledown - Cut	**Sown Ryegrass Cut**	**Sown Ryegrass/Clover Cut**	**Sown Red Fescue Cut**	**Tumbledown - -**
Pterostichus melanarius					
1989	48 ± 7.8	54 ± 8.2	29 ± 6.1	31 ± 6.2	60 ± 8.7
1990	76 ± 13.2	38 ± 9.4	26 ± 7.7	34 ± 8.9	62 ± 11.9
1991	178 ± 19.4	67 ± 11.9	20 ± 6.5	62 ± 11.4	48 ± 10.1
Pterostichus niger					
1989	14 ± 3.4	26 ± 4.7	51 ± 6.6	10 ± 2.9	23 ± 4.4
1990	14 ± 4.3	57 ± 8.8	69 ± 9.7	31 ± 6.5	42 ± 7.5
1991	25 ± 7.8	96 ± 15.2	51 ± 11.1	50 ± 11.0	38 ± 9.6
Nebria brevicollis					
1989	31 ± 5.2	16 ± 3.7	23 ± 4.5	31 ± 5.2	26 ± 4.7
1990	36 ± 6.1	4 ± 2.1	6 ± 2.5	17 ± 4.2	36 ± 6.1
1991	34 ± 3.6	11 ± 2.0	2 ± 0.7	3 ± 1.0	5 ± 1.3

CONCLUSIONS

We have found that Correspondence Analysis has been a useful technique to generate hypotheses about the patterns in a large and complex data set. Nevertheless, the data arise from a formal experiment set up to test the differences between treatments. Generalised Linear Modelling proved a useful method of testing these differences.

Ground beetle activity differed between the management treatments which were tested in the set-aside experiment.

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FIG 1

Plots from correspondence analysis with supplementary points from dates added

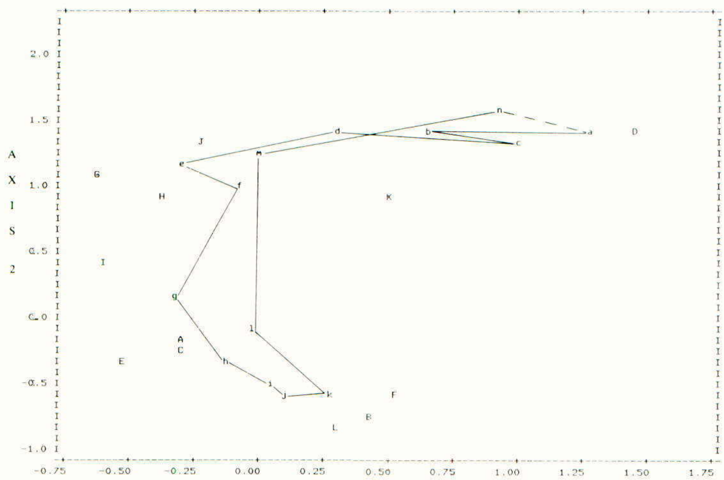
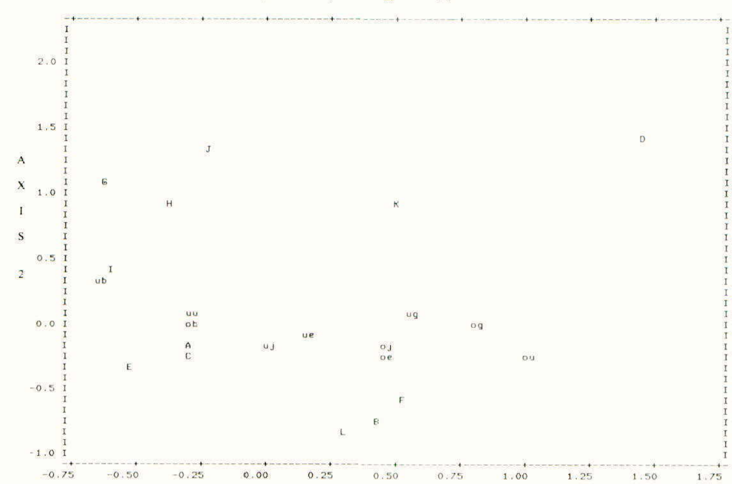


FIG 2

Plots from correspondence analysis with supplementary points from site × treatments added



Axes 1 and 2: eigen values derived from correspondence analysis

5.
Alternative Uses of Set-aside Land

Session Organiser and Chairman: BOB ROBERTS
Session Organiser: JANE HOPE

THE POTENTIAL FOR BIOMASS PRODUCTION FROM CROPS ON SET-ASIDE LAND

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ABSTRACT

A large area of land in the EC and UK is surplus to current food production requirements and appears to be destined for set-aside. Biomass crops offer the potential to sustain productive agriculture on this land. The qualities of a fuel crop are considered, some candidate crops discussed and potential yields explored. It is concluded that the current area of UK set-aside producing biomass crops at a realistic yield level could produce the energy equivalent of 1.34 million tonnes of oil, but much further research is needed to develop viable new crop systems.

INTRODUCTION

Estimates of the total area of land in the EC that will be surplus to food production requirements by the year 2015 vary between 20 and 40 million hectares (Grassi & Bridgewater, 1991). In the UK alone it is estimated that 2 million hectares will have to be redeployed to alternative uses (North, 1987). Whilst there may be scope for new specialist crops, leisure use or development, it seems likely that a large area will have to be set-aside. There is therefore potential for this area to be used to produce crops for fuel or industrial raw materials. When compared to set-aside, such crops have the potential advantages of maintaining the managed look of the countryside, sustaining and possibly enhancing the rural economy, providing greater crop species diversity and offering environmental benefits by providing renewable raw materials as an alternative to those from fossil sources. This paper considers the potential for the production of non-food crops on set-aside land for use as fuel. It deals only with crops other than trees, as the latter are considered elsewhere (Foster, 1992).

YIELD POTENTIAL

Each of the 5 million hectares of arable land in the UK receives the equivalent of 1,000 k Watts (W) of energy from the sun (Monteith, 1977). Physics and physiology dictate that 97% of solar radiation is reflected or dissipated as heat. Nevertheless, about 3% is available for conversion through photosynthesis and we at present only harvest about 0.3% (Monteith, 1977). It is suggested that loss of efficiency arises because farmers are unable, with arable crops, to maintain photosynthetic canopies in all fields throughout the year; that the canopies often do not intercept all the sun's radiation, and that they often suffer from disease, drought or have to compete with weeds. Also, only about half of the dry matter formed is harvested as grain or root for commercial use (Harvey & Sylvester-Bradley, 1992). The success of crops grown specifically for their capture of energy rather than for food will be dictated by the extent to which they can maintain a complete canopy throughout that part of the season with significant radiation levels, in a disease-, drought- and weed-free environment, and by the proportion of the assimilated dry matter that can be harvested. An energy crop that was near-perfect in each of these respects could be expected to yield about 50-60 t/ha d.m., equivalent to about 30 kW/ha/year of energy in the above terms (Harvey & Sylvester-Bradley, 1992).

FUEL CROP CHARACTERISTICS

The ideal fuel crop (Anon., 1991) might have the following attributes:

a). Dry harvested material for efficient combustion.

b). Perennial growth to minimise growing costs and lengthen the growing season.

c). Good disease resistance such as exhibited by the Gramineae.

d). Efficient conversion of solar radiation to biomass energy. Therefore, crops with a prolonged leaf canopy and the C4 photosynthetic pathway (Monteith, 1977; Long _et al_., 1989) would be preferable.

e). Efficient use of nitrogen fertilizer and water such as exhibited by perennials and C4 pathway species (Jones _et al_., 1989; Long _et al_., 1989).

f). Yield close to the theoretical maximum. For C4 pathway species, the potential yield of d.m. in temperate climates has been quoted as 55 t/ha/year and for C3 species, 33 t/ha/year (Anon., 1991).

These characteristics might be found in an example of our present range of crop species or in a species which is yet to be exploited.

THE POTENTIAL OF EXISTING CROP SPECIES

Existing crops have generally been developed to maximise a single component of biomass yield. Whilst different cereal species offer different grain yield potential, total biomass yield is broadly similar. This is illustrated in the data derived from the National Institute of Agricultural Botany trials series (Table 1). The d.m. figures in brackets assume that the crops can be harvested in ideal conditions, which is not always the case. Fodder beet offers the best yield potential, but the low dry matter at harvest makes it unsuitable for combustion. The most suitable of our current crops can only meet three of the above characteristics at best.

THE POTENTIAL OF WILD PLANTS

Some wild plants have evolved for survival by making exceptionally rapid and substantial growth thus capturing light, water and nutrients before their rivals can. Wild C4 plants would seem promising raw material from which to select potential biomass crops. One such genus of wild plants is _Miscanthus_ which occurs naturally from subtropical to cool temperate

Table 1. Experimental plot yields of d.m. and typical crop d.m. percentage at harvest (Harvey, 1990; Ingram, 1990).

Crop	Yield (t/ha d.m.)	d.m. (%)
Winter wheat whole crop	11.6	(85)
Spring barley whole crop	10.8	(85)
Italian ryegrass - 3 cuts	13.9	(85)
Perennial ryegrass - 3 cuts	12.1	(85)
Forage maize	11.9	30
Fodder beet - roots	14.9	19
- tops	3.7	9
Potato	10.5	21
Carrot	6.5	13
Winter oilseed rape - seed	3.8	91
- straw	7.0	90

areas of Asia and Africa, and is grown mainly as an ornamental in western Europe and north America (Numata, 1975; Clayton & Renvoize, 1986; Green, 1991; Sloth, 1986; Bailey, 1935). Miscanthus is a perennial rhizomatous grass with the C4 pathway of carbon dioxide transport (Clayton & Renvoize, 1986; Bunting, 1978) which forms annual bamboo-like canes up to 4 m in height. The canes are about 100 mm in diameter and dry out over winter. Plantations established from rhizomes take about three years to reach full yield potential. The plants are harvested when dry prior to the start of spring growth.

Miscanthus would seem to meet the first five criteria of an ideal fuel crop as stated above. As far as the sixth is concerned, yields in Germany, have been quoted in the range 11.7-25.3 t d.m./ha/year (El Bassam & Dambroth, 1991; Kolb et al, 1990; Sutor et al, 1991; Sutor, 1991) and in Denmark as high as 44 t d.m./ha/year (Sloth, 1986). These annual yields are generally higher than those for other crops tested in these countries. No reliable yield data are available from the U.K. It is probable that yields will be similar in the U.K. to those in Denmark and Germany because of the similar climates, but until replicated experiments are laid down and evaluated we cannot be certain. ADAS work on this aspect, with funding from the Ministry of Agriculture, Fisheries and Food, commenced in 1992 on three sites and will be expanded in 1993 with funding from the EC as part of the Miscanthus Network. At this stage, the crop does appear to offer the reasonable prospect of annual yields in excess of 20 t/ha d.m. from established plantations and the material as harvested would appear to be suitable for direct combustion for energy generation.

Some other candidate species have been evaluated under UK conditions, and Spartina spp have given annual yields in the range 7 to 20 t/ha d.m. (Long et al., 1989; Long, 1991). Arundo donax has given high yields in Germany (El Bassam & Dambroth, 1991) but this native of the mediterranean region is not fully winter hardy. Other grass species appear to be high yielding, but do not appear to have been evaluated. These include Cortaderia selloana (pampas grass), Chusquea culeou and Sasa spp (Bamboos) and hybrids of Miscanthus and sugar cane. Various perennial Compositae are also apparently high yielding, but not yet evaluated in the UK. Many plant species show promise when seen in the wild, but cropping can reduce yields dramatically in subsequent years. Nevertheless, further evaluation of wild plant species may reveal more candidates for fuel crops.

ENERGY YIELDS

Different crops are likely to have similar calorific values (Grimm & Strehler, 1987) per unit weight of d.m. Thus, 1 kg of crop d.m. is equivalent to approximately 0.4 kg of oil in energy content. An annual yield of 20 t/ha d.m. would therefore represent the energy equivalent of 8 tonnes of oil per hectare. The current UK total of about 167,000 ha set-aside (Clarke & Cooper, 1992) could yield the energy equivalent of 1.34 million tonnes of oil. Obviously, any assessment of the value of this output would have to take account of the energy put into crop production, both directly in terms of cultivations and indirectly in terms of fertilisers.

CONCLUSIONS

Miscanthus appears to posses most of the characteristics of the ideal fuel crop and to offer yields in excess of those obtainable from current crop species. If this potential is confirmed under UK conditions it will then be necessary to develop an understanding of the agronomic parameters affecting the growth and productivity of the crop, including the effect of site, soil type and pH, water availability, nutrient requirement and transport, plant population and spacing, weeds, pests and diseases. Propagation would be a particular issue with *Miscanthus* because many of the genotypes currently available appear infertile under UK conditions and establishment of crops from rhizomes is likely to be expensive and time consuming. Obviously, at this stage we are only able to work with the genotypes available currently and breeding and selection would have an important role to play in the further development of yield potential once the initial promise has been demonstrated. Other crops need to be screened and those of potential subjected to more detailed evaluations of yield potential as are underway for *Miscanthus*.

This paper has only considered the agronomic potential offered by fuel crops. The development of new crop systems will require the development and application of appropriate infrastructure for utilisation. Power plants require a regular supply of fuel and *Miscanthus*, in common with many candidate crops, is harvested once a year which creates problems of storage and supply. At this stage it seems likely that its use will have to be integrated with other fuels. The value of fuel crops will be a factor of their calorific value in relation to the value and price of oil and the overall energy balance will dictate their viability. There are many drawbacks to be overcome before they can be adopted widely, but they do offer the possibility to make productive use of set-aside land. Whilst the production of energy from renewable sources is attractive in environmental terms, a major benefit of these crops may accrue from their ability to maintain the managed look of the countryside and sustain the rural economy. All these factors demand that they be investigated thoroughly and urgently.

ACKNOWLEDGEMENTS

This paper is based on a review of the potential of Miscanthus as a UK fuel crop which was funded by the Energy Technology Support Unit.

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WOOD FUEL PRODUCTION FROM SHORT ROTATION COPPICE

CAROLINE FOSTER

SUMMARY

In the light of the ongoing need to identify new energy sources, the idea of using Wood as a Fuel is arousing ever more interest in the UK. Both forestry residues and short rotation coppice have the potential to help meet our energy requirements. The attractions of using wood fuel are considerable. It is environmentally friendly, renewable and represents for those who grow and supply it, a source of income and, for those who use it, a locally-produced, reliable source of energy, free from any unexpected price rises.

In this paper the focus will be short rotation coppice as an arable energy crop. It will consider the key steps in production and harvesting, along with clonal selection, disease environmental impacts and the future direction of the crops development.

INTRODUCTION

Renewable energy is the energy which can be harnessed from natural and sustainable resources; for example - wind, flowing water, the sun or heat from the earth. Waste materials can also be regarded as sources of renewable energy, as can crops which are grown specifically as a fuel.

Renewable sources of energy are attractive for many reasons. Environmentally they are attractive as they "recycle" natural resources for energy production, rather than exploiting fossilised materials currently stored deep in the earth. All renewable energies can be described as "carbon dioxide neutral", although individual energy equations will differ. In energy crops for example, any carbon released on combustion is only that recently sequestered in growth. When used to replace fossil fuels therefore, a net reduction in carbon release occurs. In addition, there will also be a net reduction in the release of other elements in fossil fuels like sulphur. In this way, the use of renewable energy sources in place of fossil fuels, can help to retard or ameliorate global warming and acid rain.

WOOD AS A FUEL

As mentioned, there are a number of sources which can provide renewable energy. One of which is wood. This should come as no surprise when you consider that wood is in fact the nations oldest fuel.

Waste wood or timber from derelict buildings etc, is not considered as part of this wood resource. This sort of wood waste is, by and large, processed wood - ie; treated in some way, be it paint, varnish, preservative etc. This means that on combustion of the wood, pollutants are produced which require strict emissions regulation. The wood resource discussed here is thus restricted to untreated green wood from the forest or farm.

Wood as a fuel can be derived from two largely separate sources. The most readily available source being from conventional forestry operations. This does not include the wood which is currently used for timber, pulp, paper or any other traditional wood products. It refers to that wood which is currently unused and thus considered to be a waste - for example; residues from conventional forestry harvesting operations, thinning operations, clearing of derelict woodlands, wood waste from management operations or from amenity woodland etc. This wood represents a limited resource, although sizeable - up to 1.3 million tonnes of coal equivalent a year.

In order to increase the wood resource available, it is possible to grow wood specifically as a fuel on a short rotation coppice system (SRC).

For any energy generation scheme to be worthwhile, the energy produced must be many times greater than the energy input required to establish and operate the scheme. It is therefore essential to know the energy budget for the particular energy generation method. To be truly renewable, an energy source must require only trivial amount of fossil fuel for its generation. Estimates available in the literature suggest that the energy output of short rotation coppice is 10 to 12 times greater than the energy inputs (Hall et al, 1990; Ledig 1989). In order to clarify this energy ratio and ensure that these figures are accurate, work is underway to establish the energy and carbon budgets of short rotation coppice as a fuel.

SHORT ROTATION COPPICE

Many woody species respond well to coppicing and can produce high annual "biomass" yields. The two species which are the most productive are willow and poplar. Results from experimental trials suggest that sustainable yields of 10 to 15 dry tonnes/ha can be produced annually (ETSU B 1078). This level of production comes from close spacing (willow 1x1m; popular 1x1.5m) and short cutting cycles (3 & 5 years respectively). The coppice is established by planting short (25cm) unrooted cuttings in early spring. The cuttings then produce long whips (approx 2m) which are cut back prior to the next seasons growth. This induces vigour in the roots leading to production of a number of shoots. After 3 to 5 years the crop is harvested. It is estimated that the stool will remain productive for up to 30 years. In order that the grower can achieve an annual income however, it is possible to plan the crop in rotation to produce an annual harvest. This will also lead to reduced planting costs as the cut back from the first years growth can be used as cutting stock for the next rotation.

Planting can be undertaken either by hand or with the use of an adapted vegetable planter. In Sweden sophisticated machinery is available for planting, spraying and weed control of these crops. Although expensive, they are very effective. Similar machinery will be available in this country in time.

Selection of suitable clones prior to establishment is vital. The quoted yield figures refer to willow and poplar clones which respond well to this sort of coppice system. However not all willow and poplar are suitable. A list is available of the recommended clones for arable energy forestry from the Forestry Commission.

In order to achieve successful establishment it is important to prepare the ground prior to planting and maintain complete weed control in the first 18 months. This period is particularly important as the unrooted cuttings compete for water with the weeds. If weed control is not complete substantial losses in terms of stool survival and total yield will ensue (Parfitt et al, 1992). After establishment however, the importance of weed control reduces as the roots out compete the weeds. Over the life of the stool bed the need for weed control is minimal. It may be possible to further reduce the use of chemical weed control measures by using alternative techniques.

Short rotation coppice, or Arable Energy Forestry, has been estimated to require 1/5 of the nutrients of a traditional arable crop (ETSU B 1078, 1990). The nutrient drain on the land will therefore be much reduced. There does however remain a nutrient need. The biggest demand from this crop is likely to be water, although this again has been estimated as less than other arable crops (personal communication).

If the water and nutrient availability to the crop were increased, an increase in yield might be expected. As the root system of short rotation coppice tends to be lateral and close to the surface, it forms a continuum which may act as a biofilter. Such a biofilter may therefore act as a soak for water and nutrients in sewage sludge or farm slurry. In this way the crop would gain from an organic source of water and nutrients, supplied at a rate that minimises or excludes risk of pollution to waterways.

In terms of the energy equation mentioned earlier, the potential yield gains can be offset against the energy required for applying sludge or slurry. In this way the overall energy cost or benefit to sludge/slurry as a fertiliser would be clearly seen. To complete the picture, the energy cost/saving resulting from incineration of the sludge should be considered. Ongoing research in the Department of Trade and Industry's Wood as a Fuel programme is addressing all these issues and as information emerges it will be made available.

It is important to remember that sewage sludge contains low levels of potentially toxic elements (PTEs). The fate of these elements after application to SRC is uncertain at the present time, although research is ongoing to clarify this. In addition there is still much speculation as to the long term impact of low levels of sludge application to land. Recommendations as to the likely value of sewage sludge as a fertiliser will no doubt be made when more information becomes available.

After 3 to 5 years the crop must be harvested. This takes place between leaf fall and leaf set. Harvesting can be carried out either by hand with a brush cutter, or using a purpose built coppice harvester. The coppice harvester, (designed and built for the Department of Energy (now Department of Trade and Industry) programme at Loughry College, Northern Ireland) is a tractor drawn machine which cuts and bundles the coppice sticks. The harvester is designed for an inter row spacing of 1m, the bundles weigh approx 300kg and the output is approximately 1ha a day. As the harvester is drawn over the stools two contrarotating augers gather the stems which are then cut at the base by a circular saw. The cut stems are pulled back into the bailing chamber by packing arms. When the bail reaches the appropriate size it is tied and ejected off the back by a hydraulic ram. The bundles can then be collected using a standard buckrake or forwarder.

The bales are subsequently collected to the side of the field where they can be stored until required. By not chipping the wood into a form suitable for use at harvest no microbial breakdown of the fuel results and the need for expensive storage is negated. Additionally, air-drying of the cut bundles results during the summer, rendering the wood more amenable as a fuel when it is subsequently removed for chipping and use.

The cut stools do not appear susceptible to damage by tractor tyres or immersion in mud, and re-sprout in the spring. It has been estimated that the coppice stools will remain in production for some 30 years before replanting is necessary. During this time, the size of the stool and its productivity will reach a plateau with a decline in yield towards the end of its life. Such is the root activity of an established stool that weed completion is unlikely to be a problem and thus no further weed control is likely after the first two years of establishment.

Willow and poplar are both susceptible to disease, in particular rust. Poplar has been subject to breeding and since the new clones, are more rust tolerant, the disease problem is reduced. Willow has had no such breeding and remains susceptible to rust attack. Individual willow clones react to rust in different ways, some are attacked by rust but tolerate the infection, others remain untouched whilst most suffer yield loss (Royle 1992). The impact on yield is dependent on the race of rust and the time of infection. If infection occurs early in the season a serious epidemic may develop. Yield loss can be as great as 100% if the epidemic results in stool death, however this is rare and a result of planting a particularly susceptible clone (Royle 1992).

In order to overcome or reduce the impact of rust attack, monoclonal plantations should be avoided. The precise number, variety and design of mixed clonal planting is still under assessment, although 5 to 10 clones should provide reasonable security. It is unlikely and probably unwise to try and eradicate rust from the plantation. Control of the epidemic will probably be more successful through plantation design, choice of clone, minimising overwintering sites and biocontrol (Royle 1992).

A natural biocontrol has been identified in a number of the plantations at Long Ashton. The agent arose in the plantation during a particularly bad epidemic and eradicated the rust attack. The agent is a Darluca species and is now under further investigation. If it proves to be suitable for biocontrol of rust, the rust problem will be very much reduced. It is still far too early to speculate on the likely impact of Darluca.

FUTURE DEVELOPMENTS

The techniques for crop establishment, management and production are therefore understood. The costs involved in short rotation coppice production are understood, and provisional information regarding yield and site clone variation is available (Maryan 1992; Ford Robertson 1992; ETSU B 1078, 1990; ETSU B 1171, 1989). All this information suggests that it is possible to make this crop viable, if a market can be identified. Work within the Department of Trade and Industry's programme is underway to identify markets and stimulate their development. For the purposes of this paper, discussion of the activities in this area will be restricted to the farm wood fuel and energy project referred to below.

To date all the information available on SRC yield and performance, relevant to the UK situation, has been obtained through research plots distributed within the UK. This information forms the basis on which growers can build, and hopefully improve.

The Forestry Commission Woodland Grant Scheme now includes payment for short rotation coppice. There are scales of payment dependent on the area planted. Payment is split over a ten year period with 70% in year 1, 20% in year 5 and 10% in year 10. If the plantation is removed in this time the payment is refundable. The WGS is also subject to a number of Forestry Commission environmental. The capital costs of establishing the crop, fencing and weed control are covered by the WGS, so although no annual payment and therefore income, is available prior to the first harvest, all costs are covered. The only ongoing cost then becomes harvesting which will be covered by the income from the crop. Harvesting will be more economic if a number of farmers work together in a cooperative thereby reducing costs. Also, bearing in mind that once the crop is established it requires little maintenance, a group of farmers working together would have 4-6 years to develop markets local to them.

The Wood as a Fuel programme is developing five farm wood fuel and energy centres in the South of England. Each of the five farms will act as a focus for other farms in the locality which will then work as a cooperative. Each of the five farms will establish 10ha of SRC over a three year period, this coppice plus the coppice from other farms in the group will be used to feed local markets. These markets will be developed by the project. The costs of establishment of the crop will be covered by the WGS and the project hopes to demonstrate the long term commercial viability of wood as a fuel.

The five cooperatives will be the first production sites of arable energy forestry, grown on the farm. The information coming from these sites will form the first "real life" information available, and will provide accurate estimates of the real on farm costs. In order to provide this information the economics of the operation will be closely monitored, as will the crop performance by ADAS. The information will all then be available for future plantings. In addition, an environmental impact assessment (EIA) will be carried out by ERL on each of the five sites. The EIA will be a monitoring process from pre-establishment on through two cutting cycles.

ENVIRONMENTAL IMPACT

To date the only research on the environmental impact of SRC in the UK is a desk study based on expert knowledge and theory. The proposed EIA will thus provide valuable data which can shape the way the crop is managed in the countryside. In addition a further study has been initiated by the Game Conservancy which will establish the wildlife status of current trial sites and then recommend ways in which the conservation value of SRC can be enhanced. The main opportunities will arise through management of the access rides around and through the coppice crop, also through ground cover underneath the crop. These access routes could be considered as wildlife or recreation corridors as it is here that the flora and fauna will be richest, and here that any public access will be routed.

Currently the area bounding agricultural crops is narrow and often subject to the same spraying regimes as the crop itself leaving the boundary "sterile" and easily infested with weed species. The practice of conservation headlands has substantially improved this situation and now many crops are bounded by a semi-stable wildlife community. The extended access route bounding SRC mentioned above therefore offers a considerable wildlife opportunity in comparison to traditional agricultural crops.

Some early observations from current trial plots suggest that the coppice is a haven for wildlife - in particular birds. The game conservancy produce an "Index of holding capacity" for game birds in different habitats (Game Conservancy 1991).

Table 1. Index of Holding Capacity for Game Birds in different types of Woodland.

Habitat	Index of Holding Capacity/ha
Mature Beech Wood	7
Instant Spinney	16
Birch Regeneration	16
Unmanaged Hazel Coppice	17
4 Year Old Hazel Coppice	42
Willow Coppice	42

In addition, early ringing results from a plot in N Yorkshire identified 27 different species and 700 birds. The species range covered ground, insect and seed feeders, predators and a swallow roost (personal communication). The results of a survey of a willow plantation on cut over bog in N Ireland were similar to the above (Kavanagh 1990).

The environmental impact of SRC will be more widespread than merely wildlife. Large areas of arable energy forest will naturally have a visual impact, although careful siting of the plantation should minimise this. Even so, the perception of this impact may well be highly varied. As the crop is deciduous and planted on a rotation it will be continually changing. It also grows quickly and will thus "green" the landscape rapidly. The stability caused by a long lived crop, in association with the continually changing habit, may be most attractive to people. Linking the crop with established woodland may further improve the wildlife potential. In addition to this, it is important to remember that the crop does not resemble woodland. It is a farm crop which happens to be a woody species. Visually it is quite different to woodland and description of it as such may foster inaccurate expectations and perceptions about the crop.

The environmental implications of this energy crop extend beyond the local and even national scale. As mentioned at the start, energy crops could have a significant impact in reducing carbon emissions and thus climate change. When considering the individual implications of energy cropping, it is worth taking a step back and remembering all the other issues involved - micro to macro.

The Farm Wood Fuel Energy Project moves 'wood as a fuel' from pure research in to a production and market development phase. This does not exclude further research, rather it includes more activity in market development demonstration phase.

CONCLUSION

Fuel wood is available now at a price which is becoming increasingly competitive with fossil fuels.

Arable energy forestry can produce fuel wood from land removed from food production. This system has high productivity and the economics of the crop have recently been improved with the availability of the Forestry Commission Woodland Grant Scheme. Income from this crop will depend on how efficiently the farmer grows and harvests the wood, and what price he must sell the wood to compete with fossil fuels, taking due regard to the increased cost of combustion plant.

The crop can remain in production for some 30 years and is a low input crop both in terms of time and chemical sprays etc.

From both sources, fuel wood will likely be supplied to long term supply contracts giving income stability for the producer, and price and supply stability for the consumer.

Environmentally, wood as a fuel offers a number of opportunities aside from the aspects of ameliorating the impacts of climate change. These opportunities range from enhancing the wildlife potential of arable cropping, through to landscape diversity, reduced inputs and a possible disposal route for sludge or slurry.

ACKNOWLEDGEMENTS

The Wood as a Fuel programme is funded by the Department of Trade and Industry. Thanks are given to everyone involved in the programme.

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THE USE OF SET-ASIDE LAND FOR GAME CONSERVATION

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ABSTRACT

A major motivation for landowners, farmers and estate managers to sympathetically manage land under their stewardship is the conservation of game. Set-aside land, if correctly managed has the potential to provide holding cover, nesting cover and brood-rearing areas for gamebirds within the arable landscape. Management options within the various existing and proposed set-aside schemes are reviewed and assessed for their potential as habitats for gamebirds. Changes to the management recommendations are suggested to improve the potential of surplus arable land for game.

INTRODUCTION

The United Kingdom's five-year Set-aside Scheme (1988-1992) was introduced to reduce surplus commodity production within the EC. Four options were available to manage set-aside land, namely permanent and rotational fallow, the non-agricultural option and the woodland option. Successful game conservation requires that several elements of cover or provision of resources must be available in suitable habitats at crucial times of the year. Essentially these are winter cover or woodland for holding and showing birds, nesting cover for hens in the spring and brood-rearing cover for foraging chicks when they have left the nest. Therefore a mixture of management options are likely to fulfil the requirements for these types of cover. These are summarised in Table 1.

TABLE 1. Uses of set-aside land for game

Strategy for game	Useful options
a. Winter cover for holding and showing birds	Permanent fallow + non-agricultural use
b. Woodland planting	Woodland
c. Nesting cover	Permanent fallow, non-agricultural use, woodland
d. Brood rearing areas for young chicks	Permanent, rotational fallow, non-agricultural use

The priorities for management depend on the nature of the gamebird population under consideration. For a reared pheasant shoot the main consideration would be winter cover and woodland. For wild pheasants and partridges, nesting sites and brood rearing areas would be the priority.

The 5-year set-aside scheme could be readily used to provide winter cover with benefits to reared game and, to a much lesser extent, wild populations. However, the encouragement of wild game populations is much more difficult and was not adequately catered for under the 5-year scheme.

WINTER COVER

The non-agricultural use was probably the most suitable to provide holding cover for game in the winter and to provide winter feed. With no restrictions on weed control or fertiliser use, strips of traditional game cover crops like maize and kale could be established. Under the fallow option restrictions on agrochemical use made, for example, the growing of maize without weed control or kale without bag nitrogen impossibly difficult. Mixing these crops with others such as millet, tic beans or quinoa classed them as unharvestable mixtures, and within the non-agricultural option.

Game crops for winter cover could also be considered under the fallow option, but only those that could be established without fertiliser. Cultivations were permitted and some weed control with chemicals was possible after specific approval from MAFF and a derogation from the rules of management. Game crops that came under this option were the catch crops: mustard, texel greens, stubble turnips and fodder radish. These are normally broadcast into arable crops 10 days or so prior to harvest, thus providing suitable cover for partridges and early pheasants later in the autumn. Weed control is not of paramount importance in these fast growing crops. If the seed rate is not too high, open and thin patches allow the birds to run through the crops. MAFF stipulated that pieces of land should be set aside in blocks of a minimum of one hectare. This could be done in strips provided they were at least 15 metres wide, and one hectare in total. This was ideal for planting many forms of winter cover along the guidelines often suggested by The Game Conservancy's Advisory Service. However, the use of set-aside land to provide game cover will only utilise a small proportion of the total farm area. Twenty percent is considered to be a large area to put down to game cover crops. The ability to drive and show birds would become seriously reduced if they were dispersed over too large an area of set-aside land.

Game cover crops are also valuable for other ground nesting species especially the endangered stone curlew (Sears, this volume). However the future of using the non-agricultural option under the Five-year Scheme for game cover may be in doubt. The proposed 15% annual, rotational fallow option which will run from harvest to harvest will not allow the establishment of crops in the spring of one growing season, to be utilised during the winter of the next season. Retaining stubbles over the winter could however provide excellent feeding opportunities for game and the use of catch crops may be allowable under the annual rotational scheme. Provisions for land use within the proposed 20-year permanent option are yet to be formulated but must provide for long-term habitat creation and management.

WOODLAND

Woodland was also an option under the 5-year scheme and such plantings received annual payments for five years in addition to being eligible for the planting grants available under the Woodland Grant Scheme.

To qualify for Set-Aside the plantation had to be at least 1 ha in size. This is a suitable size for pheasant drives and provides small woods with plenty of woodland edge, ideal habitats for holding high winter densities and promoting breeding pheasants (Robertson, in press). Woodland is of known benefit to pheasants and can be planted in blocks rather than in the strips we recommend for many other types of set-aside cover. As such it may be a useful component of any farm's set-aside plans to help make up the percentage of arable land that must be taken out of production. As well as providing new drives, woodland is also excellent nesting cover and, when young, can be a valuable brood rearing area for pheasants and partridges. Unfortunately the woodland set-aside option is doomed under the new rotational scheme but other options are available to take surplus agricultural land out of production, including, presumably, the plans for the long-term set-aside scheme and the new Farm Woodland Premium Scheme.

NESTING COVER

To be of use as nesting cover for wild gamebirds an area to be set aside must be both attractive to the birds and provide them with security from predators and disturbance. Permanent fallow set-aside was the option to choose here.

Pheasant are generalists in their selection of sites and some birds will attempt to nest in almost any area. There have been a number of large-scale American studies which have examined the proportions of pheasants nesting in different habitats and kept records of their success. By combining the results it is possible to gain an insight into which crops might be most successful for nesting game on set-aside land (Table 2).

TABLE 2. Pheasant nest site selection in North America.

Habitat type	% of Area	Nests per ha	Preference or avoidance	% nest success
Woodland	2.1	14.6	Preferred	46
Fencelines/roadsides	3.9	4.7	Preferred	19
Alfalfa/lucerne	9.5	2.3	Preferred	7
Flax	1.0	0.9	-	44
Pastures	28.3	0.6	Avoided	35
Cereals	49.0	0.5	Avoided	36
Other habitats	6.2	1.5	Avoided	34
Total	4659 ha	5664 nests		31 %

Data obtained by combining five American studies; Baskett (1941), Stokes (1954), Linder *et al.* (1960), Trautman (1960) and Baxter & Wolfe (1973). Taken from Hill and Robertson (1988).

Woodland was the most preferred nest site, contained the highest nest density, and birds in these areas had the highest nest success. Fencelines and roadside verges were also preferred although nest success was low due to high levels of predation and disturbance. Both of these habitats are also known to be preferred nesting sites in Britain and woodland is certainly an attractive financial option under many current UK tree-planting schemes. Of more interest was the selection of lucerne. Of all crops this was the most often preferred and this or some legumes could prove to be an especially valuable form of nest cover on set-aside land. In America where it is grown as a hay crop it is typically cut during the nesting season, hence the poor recorded nest success, but if left uncut over one or two years it could provide secure sites. Pastures and cereals were avoided.

The most important consideration for providing secure nesting was the cutting regime. The recent set-aside regulations for fallow land stated that plant cover must be cut twice a year, although exemptions could be sought for the creation or maintenance of certain wildlife habitats. Care was necessary not to cut during the nesting season. In America where the annual set-aside regulations stipulated the cultivation of the crop prior to 15 July, this contributed to the declines of several game species. In particular a large proportion of hens nested in the attractive sites provided by the scheme and they or their broods were then lost during cutting. Anecdotal evidence for the problems of cutting UK set-aside and pheasant nest losses also now exists.

In Britain partridges nest predominantly at the bottom of hedges or in grassy strips between fields, particularly where they are raised above the level of the crop by means of a bank. Grey partridges select areas rich in dead grass and red-legs select nettles (Rands, 1987). Neither species regularly nests in woodland although they sometimes select arable crops, hay, or even silage fields or young woodland plantations. They will also nest in areas of rough, unmanaged grass if these are present on a farm. Most forms of set-aside are not likely to improve nesting conditions for these species. In fact, if the headlands are planted to crops such as ryegrass, existing hedgerows may be spoiled as suitable nest sites because they could separate the young chicks from their brood rearing areas by extensive areas of dense, rank and impenetrable vegetation. Set-aside could be used to create new hedgerows or grassy strips across the centres of large fields which, if not attached to other field boundaries at either end, could prove to be relatively safe from some hedge-searching predators. In this way the field area to edge ratios could decreased in favour of non-crop cover. The precedent for the establishment of such within-field grassy banks has already been set. However, they are designed to provide cover for overwintering predatory beetles and are only 3 m wide (Thomas *et al*., 1991). In some circumstances, creating areas of rough grass may also be appropriate, though the maximum amount of such habitat needed would be well below 20% of crop acreage.

BROOD COVER

The provision of suitable brood rearing areas is critical if wild gamebirds are to flourish. Since the 1960's both wild pheasants and partridges have declined and this has been linked to depressed insect densities within cereal fields as a result of increased pesticide use. Abundant insect food is essential to the survival of chicks during the first 2-3 weeks of life.

The Game Conservancy's answer to the problems of providing insect-rich areas on the farm to feed young gamebird chicks has been to use Conservation Headlands. These provide the four ingredients necessary for successful brood-rearing, namely abundant insect food, a canopy giving safety from avian predators, the freedom to move freely through the vegetation cover and forage for insect food and lastly that the crop has low moisture retention at ground level, so that the chicks do not become soaked while foraging after heavy rain.

Unfortunately the use of Conservation Headlands has been specifically excluded from grant aid under all the UK's set-aside schemes. Comparisons of the chick-food insect densities on set-aside and conventional cereals (Moreby & Aebischer, this volume) have failed to detect any major differences between these two land use types. However, a suitable vegetation structure is more difficult to achieve under set-aside. Grassy swards tend to inhibit chick foraging, do not provide a suitable canopy and tend to hold moisture at ground level. It is possible that other crops such as lucerne, other legumes or linseed may be more attractive but few relevant data are available. The one potential crop that is known to be selected by gamebirds and lead to improved chick survival is a mix including a proportion of cereals.

In Iowa, where the use of set-aside had been associated with declines in wild pheasant populations a series of experimental areas were established, sown with cereal mixes. Over three years the number of successful broods increased five-fold. At the end of the study the cereal mix set-aside produced four times as many pheasants per ha as non-set-aside land (Berner, 1988). This occurred through the provision of undisturbed nest sites and improved brood-rearing areas.

Similarly, in Austria it is possible to plant cereal mixes on set-aside land provided it cannot be harvested. When sown with a mixture of cereals, kale, rape, lucerne and sunflowers it is impossible to harvest but provides ideal conditions for gamebird chicks. An assessment of this mix is currently under way but, from preliminary observations, it appears to be ideal and is certainly heavily used by foraging broods. In addition, it provides winter cover, food for the adults and suitable nesting areas. On one area where this crop has been used for over three years there is now the second highest density of breeding wild pheasants ever recorded.

Cereal mixes certainly appear to be extremely attractive to pheasants, less is known regarding their suitability for partridges but this is also thought to be high. However, cereal mixes cannot be used under the current scheme and may not be allowed in future packages. This is on the basis that they may be harvested and could cause problems for monitoring. The cereal component does not need to be high, no more than can occur as volunteers in many current set-aside fields and, if mixed with kale and rape, harvesting would not be economically feasible. To fail to allow some form of cereal mix would remove the most attractive possible option for gamebirds and miss the best chance in the last 30 years to restore our depleted wild game populations.

The new 15% rotational Set-aside Scheme could be of more value to foraging chicks. If high densities of volunteer cereals are allowed to grow and the annual broad-leaved weed flora to develop, this in effect could mimic an unsprayed cereal field and be of great value to many species of the farmland flora and fauna. If farmers were allowed to control pernicious weeds by selective spraying, game conservation would greatly benefit and herbicide costs in subsequent crops would decrease. However, such herbicides are expensive, and many farmers would be unable to afford to do this. Allowing volunteers to persist also creates a "green bridge" for pests and diseases, but this could be offset by sowing a break crop after the set-aside year. Finally undersowing the previous cereal crop to establish insect-rich vegetation cover for the set-aside year would also be a valuable option to conserve the chick-food insects. The practice of undersowing has been shown to be of great value to many beneficial insect species (Vickerman 1978, Sotherton & Moreby, in press).

CONCLUSION

The recent set-aside scheme contained a number of features suitable for creating winter cover and woodlands with benefits for reared game, and some opportunities for the creation of nesting habitat. However, the benefits in terms of brood-rearing areas, essential if we are to restore our depleted wild game stocks, were low. In future schemes greater allowance for the needs of wild game species would be of considerable environmental benefit and would increase the attractiveness of the scheme for many farmers and landowners. If the guidelines for future schemes can allow the creation of suitable brood-rearing habitat, for instance by allowing cereal mixes, undersowing, and the use of selective herbicides to remove pernicious weeds then it may be possible to reverse the declines in many species of game.

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THE COUNTRYSIDE PREMIUM SCHEME FOR SET ASIDE LAND

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ABSTRACT

The Countryside Premium Scheme is an experimental scheme managed by the Countryside Commission offering incentives for farmers to adopt management practices for Set-Aside land for environmental and other public benefits. Until the recent CAP reform changes it was available in seven eastern counties of England, on land entered into the 5 year Set-Aside scheme run by the Ministry of Agriculture Fisheries and Food (MAFF).

INTRODUCTION

The Countryside Premium Scheme for Set-Aside Land is a voluntary scheme that offers incentives for farmers to adopt management practices which benefit wildlife, the appearance of the landscape, and quiet enjoyment of the countryside by the general public. The scheme was set up in 1989 with funding from the Department of the Environment, to test whether and how additional public benefits might be realised from set-aside land. It operates on land already entered into the 5 year Set-Aside scheme run by MAFF, in the counties of Bedfordshire, Cambridgeshire, Essex, Hertfordshire, Norfolk, Northamptonshire and Suffolk.

In return for carrying out agreed management of their Set-Aside land, farmers who enter the scheme receive annual payments varying from £45 to £110.

Objective	*Rate**	*Description*
Wooded margins:	£75	New or better managed hedgerows and belts of broadleaved trees and shrubs.
Meadowland:	£110	Areas of grassland for quiet enjoyment of the countryside by the local community.
Wildlife Fallow:	£45	Habitat attractive to ground nesting birds.
Brent Geese Pasture:	£80	Sacrificial pasture to divert otherwise damaging grazing of winter cereal crops.
Habitat restoration	£varies	The restoration of a variety of wildlife habitats

*Note that the rates of payment are additional to the payments provided by MAFF for participation in the underlying 5 year set-aside scheme.

Brevity precludes setting out of full details of the various management options here, but they are contained in a leaflet which is available from the Countryside Commission, and which will be made available to participants of the conference for which this paper is written.

SCHEME MANAGEMENT

The Premium Scheme is an environmental scheme run by the Countryside Commission, grafted onto a commodity control scheme run by the Agriculture Departments. Though not ideal from an administrative point of view, the arrangements have worked quite well in practice, partly because of the help that MAFF have given us in running the scheme, and also because of the willingness of the participating farmers to make it work. Farmers' motivation to do something positive with their set-aside land has been an important factor in the success of the scheme.

Entry into the scheme is at the discretion of the Countryside Commission, rather than, as is more often the case with agricultural schemes, an automatic right for qualifying applicants. There are several reasons for this approach:

a) it enables us to keep within the cash limits which apply to the funding provided by the Department of the Environment;

b) it gives us the ability to be selective in terms of the location and nature of the land being offered into the scheme. Put another way, it allows us to target our support to those schemes which seem to offer best value for public money, in terms of the environmental return on the investment. Our literature draws attention to this fact, and encourages farmers to select appropriate land, for instance to extend and improve existing woodland margins. Under the 'Meadowland' option, the only option under which public access is a condition, it makes sense to choose areas (for example riverbanks) which are attractive for quiet recreation, and which in any case might be under some access pressure;

c) it has enabled us to try a new method of funding environmental measures. Under the 'Habitat Restoration' heading, we have invited farmers who have the potential to re-create a particular sort of wildlife habitat, like a wetland or lowland heath, to come forward with their own proposals, and to 'bid' for the annual payment that they would require. We also help with the capital costs involved. Using this rather novel approach, we have been able to get a measure of the willingness and ability of farmers to come forward with their own proposals, and the benefits and disbenefits of what is effectively a bid system for payment, rather than the more usual flat rate.

THE SCHEME SO FAR

A monitoring programme for the scheme is in place, to record the effectiveness of the various options, and the efficiency of operation. Only interim data from the first year of operation is available so far, and full quantitative assessment must await further monitoring results. The following information is drawn from the interim monitoring report, scheme administrative records, and the experience of the staff managing it.

Take Up

Scheme participation has been good, at around the level needed to take up the available funds. Initial marketing advice, followed up by limited seasonal promotional activity has ensured a steady stream of applicants, with around 20% of the set-aside land in the area covered by the scheme coming under Countryside Premium scheme management.

The scheme has entrants with holdings of as little as a couple of ha., up to over 1000 ha. First year entrants into the Premium Scheme had an average of around 40% of their land in MAFF's Set-Aside scheme; so we seem to be picking up farmers with a relatively high proportion of their land in the basic scheme.

TABLE 1. Accumulated Hectarage up to November 1991

OPTIONS	BEDS	CAMBS	ESSEX	HERTS	NORFK	NTHNTS	SFFOLK	TOTAL
Wooded margins	36.66	40.89	56.45	22.63	194.42	101.16	85.50	**537.71**
WM Supplement	33.80	27.88	83.49	1.02	18.09	223.04	33.27	**420.59**
Meadowland	510.86	414.31	599.10	345.66	265.31	608.2	687.99	**3431.43**
ML Supplement	237.08	21.51	151.99	13.56	0.00	116.18	14.10	**554.43**
Wildlife Fallow	76.17	83.07	49.47	115.98	333.61	111.17	221.53	**991.50**
Brent Geese	0.00	0.00	554.20	0.00	37.15	0.00	57.70	**649.05**
Habitat Rest.	54.44	10.53	9.49	0.00	290.77	34.00	96.72	**495.95**
Total Ha.	949.01	598.19	1504.19	498.85	1139.35	1194.25	1196.81	**7080.65**
No of Farmers	20	31	48	19	45	27	56	**246**

N.B. Hectarage figures include agreements for 1989 and 1990, and applications for 1991

The Meadowland option

This has proved far and away to be the most popular option, comprising about half of the scheme acreage, probably because it yields the highest rate of payment. We were advised beforehand that farmers would be most reluctant to offer the permissive access to their land that is the main objective of this option. We found however, that because of the careful design and targeting the scheme for local use, farmers have been most willing to participate. One revealing, and not untypical comment from a farmer using this option was that not only did it allow him to manage the grassland in a way that he approved of, but even more importantly to him, it had greatly improved his standing in the local community. Instead of being seen as taking money for leaving land idle, he received the credit for providing a much needed local facility.

The Wildlife Fallow Option

Take up of this option has been less than we expected, perhaps because it is targeted at lighter land. As much of this is very productive, it has not by and large been the first choice for entry into Set-Aside. Early monitoring results note that a significantly high proportion of Premium scheme fields contained grey partridge (a Red Data Book species). Six other species, including Red Book candidates, were also recorded as being present in significantly higher numbers on premium land compared with ordinary arable controls. The management regime does seem to have succeeded in improving the abundance of ground nesting and other birds, though there is an interesting question as to whether it is significantly more productive than ordinary set-aside land with natural regeneration. In general, the interim data is insufficient for conclusive assessment to be made of the effectiveness of this option at this stage.

Wooded Margins

This is typically an option that is taken up in association with others, to improve the condition of existing boundaries, or create new ones. A number of farmers have taken the opportunity to reinstate field boundaries that had been left to decline to such an extent that they had almost disappeared, so that the availability of this option may have helped preserve the field pattern, rather than simply improve its condition.

Brent Geese

Brent Geese do actually seem to be attracted to the fields specially managed for them under this option along the east coast. There is some evidence that the precise management of the sward is critical in getting the birds to favour it, and monitoring work should help us to improve the management prescriptions and techniques.

Habitat Restoration

This option has yielded some very interesting schemes, including the restoration of species rich grasslands and lowland heath. One early lesson from our experience of this option is that farmers and landowners are often enthusiastic to restore wildlife features, but unsure about how to go about it, as their experience of land management for food production has not provided them with the requisite skills or confidence for habitat creation and management. Advising farmers on this option has taken six times as long as the average for the others options. This flags up the importance of having a good and sufficient advisory capacity with any scheme that requires farmers to undertake novel management, if good take up and value for public money is to be achieved.

Our experience of the scheme in the limited period that it has been running is that in general terms, it is likely to give us what we were aiming at - that is, an improved environment, and greater capacity for quiet public enjoyment on the set-aside land.

FUTURE DEVELOPMENTS OF COUNTRYSIDE PREMIUM AND SET-ASIDE.

Whilst the top-up approach has worked, it would not be our Commission's preferred approach to the derivation of environmental benefit from Set-Aside. Our preference would be that environmental benefits, like a regionally diverse and beautiful landscape and thriving wildlife, should be a primary objective for set-aside, rather than a bolt-on extra. Our experience of the Premium Scheme leads us to think that this is a view shared by many farmers, who are uneasy about the negative image of being paid simply to stop doing something.

Earlier this year, as part of the CAP reform process, the European Community introduced a new scheme of annual set-aside. Those who choose not to join in will be excluded from the system of supported prices. This scheme will take out 15% of the arable acreage of the Community. At the time of writing the scheme is still in its early stages of design, with the details of implementation still being worked out.

We might attempt to get environmental benefits through a top up arrangement for the new annual scheme, but they would be lost if the farmer decided to plough his set-aside and go for market prices rather than remain eligible for the arable support scheme. The evidence from the '50s Soil Bank scheme in the United States is that under strong market conditions land goes back into production. Of course it is perfectly sensible that renewed demand for food production be met, but from an environmental point of view it is not very satisfactory to see newly re-created landscape and wildlife features eliminated by a bullish Chicago futures market. Our landscapes are really medium or long term 'commodities' that are not capable of responding to the next period of over-supply by spontaneously re-appearing.

The 'accompanying measures' in the reform package contain proposals for a longer 20 year set-aside linked to environmental improvement. This scheme seems more promising, but this will not exist for at least another year, and may still be overshadowed by the annual scheme requirement unless the land entered into it qualifies as part of the area of annual set-aside required for the receipt of arable support payments.

The same case might also be made for other environmentally productive schemes which take land out of cultivation (for instance the reversion elements of ESAs and Countryside Stewardship), if they are not to be squeezed out by the annual set-aside scheme.

SET ASIDE AND THE POTENTIAL FOR NEW WOODLAND

The linkage between set-aside and new woodland is very tenuous, when common sense would suggest that the two things go hand in hand. We should be looking for some relatively simple way of getting farmers to plant woodland on set-aside land, to generally improve the diversity of our countryside, to create new lowland forests around our major connurbations, and assist with the creation of a National Forest in the Midlands. While over 90% of the land that was 'set-aside' to grass in the 'Soil Bank' scheme in the USA in the '50s was ploughed up again in the boom of the early 70s, a very large proportion of the Soil Bank land that went down to trees stayed that way, until today it is yielding useful timber.

The longer timescale of woodland and other habitat re-creation raises the questions of whether it is wise to 'lock away' the productive capacity of land for periods of 20 years or more. Of course, the creation of new woodland would need to be balanced with the creation and protection of other habitats, and the protection of our reserve of high quality land. It may indeed be sensible to target relatively long term schemes at a limited quantity of land in the first instance, whilst we come to terms with whether food over-supply is really going to be a long term feature. However, even during a period of strong markets for food crops, there is still a case for targeting some less productive land of potentially high environmental value, towards alternative, environmentally productive uses.

SUMMARY

If the expansion of Set-Aside on the scale required by CAP reform is to bring environmental benefits, those benefits need to be a clearly defined and required output, rather than a hoped for by-product.

By paying farmers to create new landscape and habitat features on land that has previously been cultivated, we will get a reduction in output. Unfortunately the reverse (i.e. that if you pay farmers to stop producing, you automatically get a better environment) is simply not the case, hence the need for the Premium Scheme. Putting output control as the first and over-riding objective of set-aside is wasteful of public funds, bad for farmers, and a missed opportunity for environmental gain.

The Countryside Premium Scheme has demonstrated that environmental improvements are achievable through Set-Aside if they are specifically targeted and rewarded. Farmers are keen to manage their land for a positive purpose, rather than do minimal upkeep.

The Government is considering extending the principles of the scheme nationwide but has awaited the outcome of the CAP reform process before acting. As things have emerged, no obvious vehicle for a nationwide scheme has emerged. The annual scheme seems on the face of it to be less suitable for a top up scheme than was 5 year set-aside. Perhaps the best hope lies in the 20 year scheme, but only if land entered into it counts towards any annual requirement for arable scheme support payment.

The potential for tree cover on set-aside has not begun to be exploited. There is a widespread concensus that lowland forestry should form a greater part of future landscapes, and what more appropriate way is there of finding a productive, environmentally beneficial use for some set-aside land?

Perhaps a longer term, environmentally productive set-aside could take a 'top slice' of land that is being taken out of production, rather than be the 'Tail end Charlie' of the accompanying measures. There is a clear case for a review of the objectives and efficiency of set aside schemes, looking carefully at the relationship between discouraging over producing, and the opportunities to re-create a more diverse landscape.

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6.
The Economic and Social Effects of Set-aside

Session Organiser and Chairman: ZÉLIE APPLETON
Session Organiser: MARTIN GIBBARD

THE ECONOMICS OF SET-ASIDE IN ENGLAND AND WALES IN THEORY AND IN PRACTICE

DAVID J ANSELL

1. INTRODUCTION

Most of the information upon which this paper is based was collected in a survey of 259 farms who participated in the first year of the 5 year set-aside programme, 1988/89. The survey work was confined to England and Wales and was carried out in the early part of 1990. In the first part of the paper the pattern of uptake is considered, then the effects of set-aside on the production of arable crops and on the farming systems of participants. From these basic features of adoption, the paper goes on to examine the cost effectiveness of the scheme and the financial implications for participants.

2. PATTERN OF UPTAKE OF SET-ASIDE IN ENGLAND AND WALES IN 1988/89

2.1 Regional distribution of uptake

The regional (MAFF regions) pattern of uptake is shown in Table 1, which shows the total numbers setting aside in that year, the total number with eligible crops and the percentage of those with eligible crops who set-aside. There does not seem to be a concentration of uptake in the less favoured cereal growing regions, like the North or Wales, but a markedly higher rate of adoption in the South-East. There is no obvious explanation for this, although the problems of farming on the urban fringe, and the greater availability of off-farm employment and income may be part of the answer.

2.2 Size of farms joining the scheme

Set-aside tends to attract larger farms. This is clearly shown in Table 2 which compares the average eligible crop area on set-aside farms with all farms with eligible crops in each region. Table 2 also throws some light on the regional patterns of uptake discussed above. Set-aside is more attractive to larger farms, because there is more opportunity to reduce fixed as well as variable costs, and because a flat rate payment per hectare compares more favourably with farming income the greater number of hectares available. Crop areas per farm are lower in Wales particularly, but also in the Northern and Midlands & Western regions, where adoption rates have been low. The relatively high rate of adoption in the South-Western region suggests other factors are at work there.

2.3 Land tenure and set-aside

There is no distinction between owned, tenanted and mixed tenancies in terms of adoption of set-aside. On surveyed farms, the balance of owned and rented land was 70/30 which is very close to the national pattern as revealed by MAFF statistics. Tenants, it seems, are as likely as owners to join the scheme.

2.4 The farmers in the scheme

A plausible hypothesis is that set-aside will attract older farmers who could reduce their work load and stress by treating set-aside as another 'pension'. There are no official figures for the age distribution of farmers for comparative purposes but several surveys have shown that the average age of farmers in England and Wales is about 50. The farmers encountered in the survey ranged, in age, from 25-85 years with a mean of 54 years, so there seems to be no evidence that set-aside has been more widely embraced by the elderly, although for some such it has been attractive. In order to establish whether older farmers might set-aside more land than younger ones, farmer age was regressed on the area in set-aside, but this revealed no significant relationship and farmer age revealed very little in the variance of set-aside area.

Some 42% of the farmers in the survey had received a formal agricultural training, a much higher proportion that that found by other surveys. They also seemed, by various criteria, including membership of environmental groups, to be more conservation minded than the average.

Various questions were asked of the farmers in the survey to ascertain whether they had pronounced conservation or environmental interests. It is difficult to judge the outcome because there is no information on these values for the total population of farmers. However, 221 out of the 249 farmers did regard themselves as environmentally conscious and of those 129 (58%) did belong to at least one environmental group or organization.

2.5 The land set-aside

The total area of land set-aside by the surveyed farmers was 9591 hectares or 37 hectares per farm. Most of the land (9088 hectares or 95%) had been put into the fallow option, with permanent fallow being the most popular. Over 70% of farms had set-aside land in permanent fallow. Only 12 farmers had set-aside land for woodland (90 hectares in total) and 45 had taken up the non-agricultural use option (414 hectares in total).

There were no marked regional differences in the set-aside option chosen, except that rotational fallow was more extensively used in the Eastern region than elsewhere. It would seem that on the larger arable farms, set-aside can be more easily used as part of a rotation, to assist in the cleaning of land and rebuilding soil structure and fertility. The non-agricultural use of set-aside land was dominated by equestrian activities. Thirty four out of forty nine separate non-agricultural set-aside enterprises were horse based. Most of these were developments or extensions of existing enterprises.

3. THE EFFECTS OF SET-ASIDE ON FARM PRODUCTION AND FARMING SYSTEMS

The general approach adopted to measure the effect of set-aside on national production levels was to establish what would have taken place on land had it not been set-aside in 1988/89. This did produce some anomalous answers however. The normal course of farm rotations means that some of the land which was used for set-aside in 1988/89 would otherwise have borne livestock. This is true of 4.5% of the land set-aside on the surveyed farms. On these farms one presumes there must have been a reduction in eligible crop area elsewhere; grass replacing crop production in the farming system.

Most of the set-aside land would have been under cereals (70%) followed in order of importance by oilseed rape 5.4%, beans 4.0% and sugar beet 1.5%. The rest is split between a few minor crops and land which farmers planned to let out or sell. A comparison of the yields which farmers estimated they would have obtained on the set-aside land, and national average yields,throws some light on the question of 'slippage'. For winter wheat, the estimated yields in all regions are lower than the average yields according to MAFF yield estimates for that year. For England and Wales as a whole the yields are lower by 17%. This gives some credence to the view that slippage does occur, as a result of poorer land being taken out of production. The relationship is less clear with respect to the other cereal crops. Yields on land that would have been under spring barley and oats is predicted to have been higher than national averages for that year and for winter barley, the 'expected' yield on set-aside land is only 9% lower than national averages. In interpreting these figures, it must be recognized that farmers were being asked to answer a very difficult question: what yields would they have obtained on particular fields in a particular year. It is likely that most farmers sought an answer to this question by reviewing the yield performance of the crops and fields in question over a number of years. In fact yields nationally were high for wheat in 1989, whilst winter barley yields were very close to the average of the previous six years, and spring barley yields were lower than average. This may explain some of the difference between predicted and national yields.

It could be hypothesized, however, that set-aside land was capable of producing average yields of spring barley which is a relatively low yielding crop, less capable of producing average yields of winter barley, the yields of which are higher, and appreciably less capable of producing average yields of winter wheat for which the yield potential is highest. Comparisons of predicted gross margins for set-aside land with typical gross margins (Table 3) give mixed results. They are lower for most cereal crops but not for all. The figures in Table 3 certainly do not give a picture of low input/low output farming on set-aside farms.

The effects of set-aside on the production of crops will depend not only on the lost production on withdrawn land, but also on related changes on non set-aside land of participating farmers. It has been hypothesized, for example, that remaining land will be farmed more intensively, or that through more timely cultivation on a smaller area they will obtain higher yields. Set-aside may also lead to a yield increase in future years when land is returned to production in a more productive condition. All farmers were questioned closely on these points and few of them thought they would have significant effects. Only 4% of farmers in the sample, for example, said they had changed their variable input levels on the rest of their cropped land. 10% indicated that they had made a significant change in the cropping pattern on the rest of their land - on the whole this consisted of a further reduction in their cropping area. The conclusion to be drawn from all this is that farmers who opt for set-aside do not make compensating adjustments in their husbandry methods which significantly affect their production leads.

Nevertheless the reduction in national production from the first year of the 5 year scheme is small. The scheme seems to have reduced national production levels by 0.5% in the case of wheat, 0.9% for barley, 0.9% for oats, 0.4% for oilseed rape, 1.7% for beans and 0.2% for peas. By the fourth year the area set-aside in England and Wales had risen to 127,893 (3.26 times the first year levels of participation). This suggests that the current reductions in crop production associated with set-aside may have risen to 1.6% in the case of wheat, 2.9% in the case of barley and oats, 1.3% for oilseed rape, 5.5% for beans and 0.7% for peas.

4. THE COST-EFFECTIVENESS OF SET-ASIDE

The costs of the scheme are the actual payments made to farmers and the administrative costs. In 1988/89, the administrative costs for the scheme in England and Wales were £1.4 million, or just over £1100 per participating farm, or £36 per hectare of set-aside land. Payments to farmers came to £7.5 million, bringing the total cost of the scheme to just under £9 million. Not all of the set-aside payment is borne by the U.K. Exchequer, for partial reimbursement of the set-aside payment is received from FEOGA. The amount varies slightly with different set-aside options and is also subject to abatement, and the contribution of the UK to FEOGA also has to be considered.

Taking these adjustments into account, the Exchequer cost of set-aside in 1989 was £6.6 million. If this total cost is allocated to the crops which would have been grown on set-aside land, in proportion to their relative importance, the cost per tonne of 'avoided' production can be calculated. These figures are shown in Table 4, and compared with MAFF's estimates of the marginal support costs of eligible crops in the same year. Whilst the set-aside costs are unlikely to vary substantially, unless there is a major reduction in administrative costs, the cost of supporting the price of eligible crops is highly variable, depending on the size of the European harvest, world prices and the EEC international price. MAFF estimate, for example, that in 1990 the marginal cost to the Exchequer of cereals production was about £60/tonne. For the future it would appear likely that a combination of falling support prices in the EC, lower levels of export restitutions and, presumably, rising world market prices, will lower the support costs and make the economics of set-aside look more unfavourable. Such comparisons, however, are not really meaningful. The MAFF, for example, have argued that the introduction of a set-aside programme was a sine qua non for the introduction of a tougher price policy. If this is the case then a more appropriate comparison would be the cost of running the support buying system in the absence of set-aside, with the total cost of the set-aside programme and the support buying system after set-aside. So many factors affect the cost of the price support programme however, that a true comparison of before and after costs, eliminating all other effects, is virtually impossible.

All that can be safely argued on the basis of factual information, is that in 1989, with the exception of oilseed rape, it would have been cheaper to support the prices of the eligible crops rather than prevent their production, given the degree of uptake that was achieved.

5. THE EFFECTS ON FARM INCOMES

The overall effects on the incomes of those farmers who were in our survey are shown in Table 5. The results show that overall, there was a net benefit of approximately £0.5 million, which represented about £2000 per farm or £55 per hectare. In addition to the actual set-aside payments received, benefits were substantially bolstered by savings in labour and machinery costs. A further approach to judging the effects of the scheme on participants' income was achieved by asking the farmers their own evaluation of the impact on their incomes. This was mostly a subjective one, as none appeared to have actually formally budgeted out the consequences. However, 38% thought that their farm incomes had increased, and a further 21% thought their non-farm incomes had increased. 41% thought that their farm income was about the same, and 76% that their non farm income was the same. 22% therefore felt that their farm income had declined and 3% that their non-farm income had declined.

There is no doubt that set-aside can make financial sense for a substantial number of farmers. It is difficult however to define the circumstances in which set-aside will be profitable. The ability to shed labour, or reduce 'lumpy' capital items like combine-harvesters will depend on individual farm circumstances. The high costs of cultivating 'difficult', inaccessible or distant fields is an important factor for some. The ability to lease farm cottages, or redundant farm buildings is also a useful additional source of income. The savings that can be made by reducing fixed costs have been limited by farmers caution in disposing of equipment or labour, given that the Scheme, or their participation in it, may not be long standing. It would be imprudent to dispose of equipment only to have to buy again, almost certainly at higher prices, at a later date.

There is one group of affected people who are losers as a result of set-aside and that is farm workers. Our analysis showed that the equivalent of one full-time job is lost for every 130 hectares set-aside. Most of the reduction is in hired rather than family labour. (82% of the reduction in man-weeks was hired labour.) It is not always a case of involuntary redundancy, however. Some workers have left farms and not been replaced, others have retired. Unfortunately redundancy does occur however. Forty seven workers involuntarily lost their jobs on the 259 farms in the sample. Presumably, there have also been secondary employment effects in some of the ancillary industries, but no attempt has been made to calculate these.

Table 1. Numbers of farmers setting aside and total numbers having eligible crops by region

	Numbers setting aside		Total number with eligible crops		% of farmers with eligible crops setting aside
	No.	%	No.	%	
Northern	146	11.5	12,659	17.3	1.2
Midlands and Western	177	14.0	15,457	21.2	1.1
Eastern	349	27.6	19,395	26.6	1.8
South Eastern	344	27.2	9,476	13.0	3.6
South Western	219	17.3	10,667	14.6	2.0
England	1,235	97.6	67,654	92.7	1.8
Wales	30	2.4	5,306	7.3	0.6
England and Wales	1,265	100.0	72,960	100.0	1.7

Table 2 Average eligible crop area on farms setting aside and on all farms

	Area of eligible crops per farm on farms setting aside	Area of eligible crops per farm on all farms with eligible crops
REGION	HECTARES	HECTARES
Northern	119	58
Midlands and Western	79	45
Eastern	98	86
South Eastern	72	69
South Western	69	40
England	86	62
Wales	44	58
England and Wales	85	58

Table 3 Comparison of gross margins on surveyed farms with 'typical' results

	Av. yields on surveyed farms tonnes/ha.	Typical* yields tonnes/ha	Gross margin (£/ha)	Typical Gross margins (£/ha)
Spring wheat	3.7	4.5	204	280
Winter wheat	5.6	6.7	394	430
Spring barley	4.0	3.8	259	300
Winter barley	5.0	5.5	400	345
Oats	5.0	5.5	431	390
Rye	3.7	4.5	212	345
Oil seed rape	2.8	3.3	491	315
Beans	3.5	3.3	423	360
Peas	3.5	3.3	376	305
Linseed	2.5	2.0	62	460
Sugar beet	35.1	40.0	741	750
Triticale	5.3	4.8	348	255

* Nix. Farm Management Pocketbook 1989

Table 4 A comparison of set-aside costs per tonne of avoided production and Exchequer support costs for the same year

CROP	SET-ASIDE COSTS Cost/tonne £	SUPPORT COSTS Cost/tonne £
Wheat	37	20
Barley	44	25
Oats	41	0
Oilseed Rape	73	115
Beans	58	55
Peas	52	25

Table 5 Estimated benefits and costs resulting from farmers participating in set-aside on survey farms, England and Wales, 1988/89

	Benfits to farmers £		Cost to farmers £
Set-aside payments received	1,863,807	Gross margins forgone	3,165,146
Savings in labour costs	830,078	Extra labour costs incurred	28,656
Savings in contracting costs	191,890	Extra establishment costs	2,142
Savings in machinery costs	715,263	Annual maintenance costs of fallow	27,861
Enhanced yields on non set-aside land	152,063	Other costs (trespass, vandalism, etc.)	4,348
TOTAL	3,753,101	TOTAL	3,228,153

Net benefit for all survey farms	£524,948
Net benefit per survey farm	£2,027
Net benefit per ha on survey farms	£55

SET-ASIDE IN FRANCE
HOW TO USE FRENCH REGULATION ?

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ABSTRACT

The E.C. set-aside regulation introduced a new crop to Europe in 1988 : fallow. The area in set-aside increased very quickly but because of the lack of data there is very little advice for the farmer on this topic. This paper presents some information about flora development in different types of green cover, gives some general advice for fallow management under French conditions and considers some economic aspects of set-aside. It seems that the minimum cost for good managment of rotational fallow is not less than 600 FF per hectare.

INTRODUCTION

In 1992, there are about 400 000 ha of set-aside in France. We estimate that with the new Common Agricultural Policy regulation the set-aside area will increase rapidly up to one million hectares.

When you take into account the constraints of the regulation (no fertilization, no chemicals, a limited list of cover crops, etc...) and the agronomic constraints (rotation, run off, nitrate leaching, impact on the next crop, etc ...) we realize that there is no simple technique for good management of set aside land.

Broadly speaking cruciferous species have too short a cycle (generally 2, 3 or 4 months), grasses grown without nitrogen are not competitive enough with weeds, and legumes (Trifolium etc...) are well known to increase the risk of nitrate leaching . At present, the farmers generally do not actively manage green cover. They just allow natural vegetation to regenerate and cut it once a year. This will not change in the future if agronomists do not try to answer the question : "How can green cover be managed at a reasonable cost and benefit the environnement and the next crop ?"

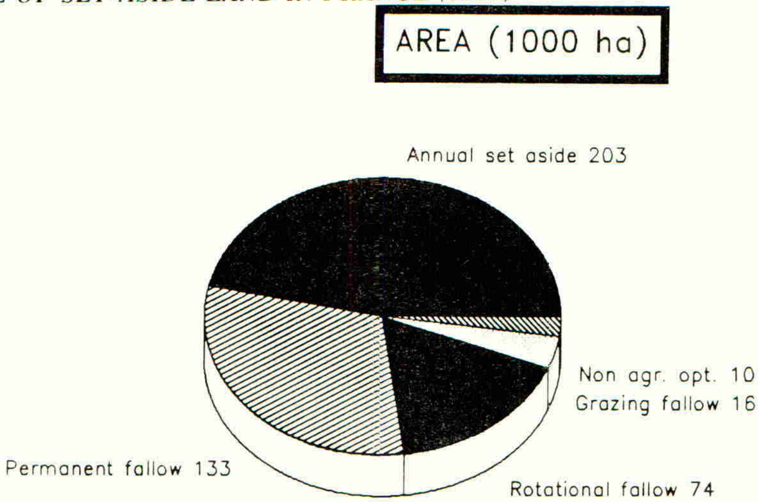
The aim of this paper is to give an initial answer to this question.

SET-ASIDE IN FRANCE

Set-aside regulations are quite complexIE for farmers because of the different options available. We will just talk about the fallow option : permanent fallow option and rotational fallow including both the five year and annual options.

In 1992, 50 % of the set-aside is annual fallow and 17 % is rotational fallow. 30 % is permanent fallow *(see figure 1)*.

Figure 1 : ***USE OF SET-ASIDE LAND IN FRANCE*** *(1991)*



TOTAL area set-aside in France 1991 : 438 000 ha

It is not necessary to remind ourselves here of the general rules for the management of the fallow land. We have just included information about the list of green cover plants and of herbicides allowed in France *(Tables 1 et 2)*.

Table 1 : The 33 species of green cover allowed in France.

Agrostis sp.	*Lotus corniculatus*	*Phacelia tanacetifolia*
Bromus catharticus	*Lupinus angustifolius*	*Raphanus sativus*
Bromus sitchensis	*Lupinus luteus*	*Lolium perenne*
Coronilla varia	*Melitolus albus*	*Lolium multiflorum*
Festuca arundinacea	*Medicago lupulina*	*Ornithopus sativus*
Festuca ovina	*Setaria italica*	*Spergula arvensis*
Festuca pratense	*Sinapis alba*	*Trifolium pratense*
Festuca rubra	*Sinapis arvensis*	*Trifolium alexandrinum*
Phleum pratense	*Brassica tanacetifolia*	*Trifolium repens*
Lathyrus cinerea	*Poa trivialis*	*Trifolium subterraneum*
Lathyrus sativus	*Poa pratensis*	*Vica sativa*

Table 2 : List of herbicides allowed in set aside scheme in France.

alloxydim	glufosinate
asulam	glyphosate
clopyralid	haloxyfop
dalapon	MCPA
dichlorprop-p (2-4 DP-P)	mecoprop-p (MCPP-P)
fluazifop-p-butyl	metsulfuron methyle
fluroxypyr	quizalofop
fosamine d'ammonium	triclopyr
	2,4 D

EXPERIMENTS ON FALLOW

The development of flora has been studied at the Boigneville experimental Station (70 km south of Paris) during the last three years *(see table 3)*.

Two plots of 1000 m^2 were sown in September 1988. The first one was sown with Italian rye grass. It was cut once only in spring 1989. Because of the drought and the poor development of the plant, cutting was not necessary in 1990 and 91. In June 1991, 100 % of the land was covered by Italian rye grass and there were only few weeds (*Bromus mollis at less than 10 %)*.

The second plot was sown with pure white clover (5 kg/ha). We cut the green cover in spring 1989. The surface of the plot was well covered from summer to winter 1989-1990. But the drought destroyed the white clover in the summer. During the second winter, the natural flora and white clover volunteers grew. In June 1991, there were 32 different species in the plot and the white clover covered 30 % of the soil.

In March 1990, two other plots were sown : the first one with a mixture of perennial rye grass and white clover and the second one with alfalfa. The cover observed in June 1991 was very good and there were no weeds. In the mixture crop the white clover was dominant.

In October 1990, two plots were sown with mustard seed and phacelia after a winter wheat . There was no emergence for the phacelia. The mustard was well developed in December but the frost destroyed the cover. In June 1991, there was in these plots a lot of volunteers of wheat but more than 30 other species of plant were present including *Polygnum aviculare, Polygonum convolulus, Alchimillia arvensis.*

Table 3 : Experiment on green cover in Boigneville

	Green cover crop	Sowing date	Management	State of the plot June 1991
Permanent fallow	Italian rye grass	1988 September	Cut 1989 end of May nothing 1990 and 1991	Good cover of Italian rye grass + *Bromus mollis*
	White clover	1988 September	Cut 1989 end of May destroyed by the drought 1990 then natural regrowth	30 % of the surface with white clover + 32 different species among which *Poa annua, Poa trivialis, Papaver rhoas Fumaria officinalis, Veronica persica, Senecio vulgaris, Sonchus asper*
	Perennial rye grass + white clover	1990 March	Nothing	Good cover with an important development of white clover
	Alfalfa	1990 March	One cut October 1990	Good cover without important weeds
Rotationnal fallow	Mustard (Previous crop W. wheat)	1990 23th of October	Destroyed by the frost in winter	27 differents species among which (volunteers of *wheat), Polygonum aviculare, Polygonum convolvulus.*
	Phacelia (Previous crop W. Wheat)	1990 23th of October	No emergence	43 differents species among which volunteers of wheat, *Poa annua, Polygonum aviculare, Alchimilla*

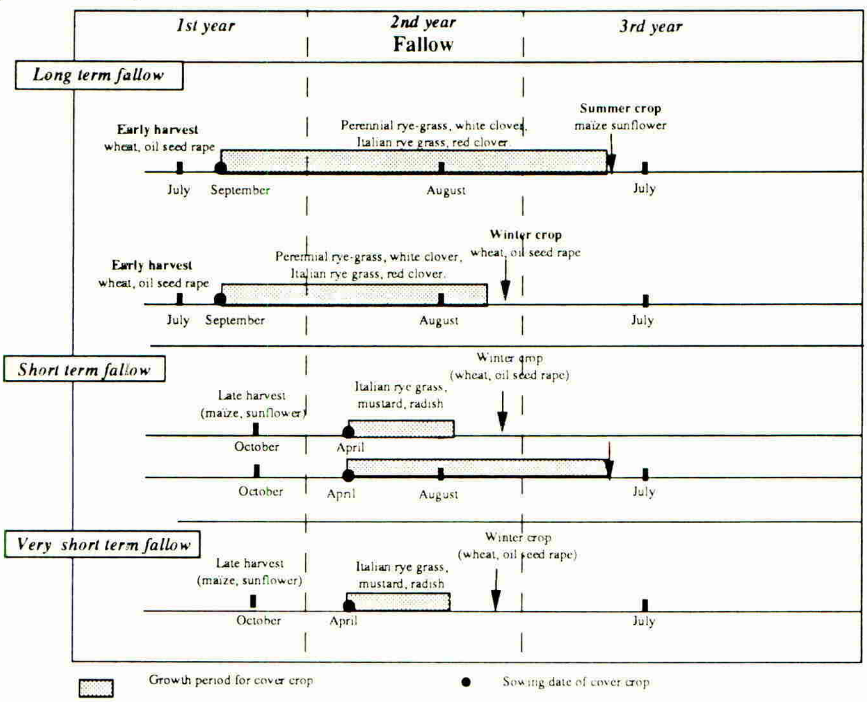
The first conclusion of this experiment is that the number of weeds in fallow increase when the soil is bare. The best green cover seems to be leguminous plants. But for a short term fallow (3-4 months), it seems necessary to use herbicides for weed control. Some annual weeds such as *Poa annua, Senecio vulgaris, Polygonyum aviculare, P. convolvulus* could create serious difficulties for the next crop.

The main perennial weeds observed in all types of fallow are thistles *(Circium arvense, C. lanceolatum).*

RECOMMENDATIONS FOR GOOD FALLOW MANAGEMENT

It seems that it is not possible to ensure a good green cover for less than 500 FF/ha. Half of this cost is used for buying seeds and the other part is intended for management (sowing, cutting and spraying herbicides). With this regulation, some species cannot be used because they are too expensive : for example Moha *(Setraria Italica)* or lupin *(Lupinus luteus, L. angustifolius).* Some other species cannot be used because seeds are not available.

Figure 2 : Crop calendar for rotational fallow



Rotational fallow

When choosing a green cover crop, you have to take into account the place of the green cover in the rotation, the length of intercrop and the emergence ability.

According to the length of intercrop we have to choose species with a short cycle like mustard or radish (Raphamus raphanistrum) or with a long cycle like perennial rye grass or clover (see figure 2). In many cases, it is recommended to sow a mixture that increases the probability of emergence and allows better competition with weeds.

Generally speaking we have to have to choose a green cover which has good agronomic effects : minimizing nitrate winter leaching, run off, etc... We have also to avoid leguminous plants like clover before peas or beans, and cruciferous species(mustard, radish) before oil seed rape because of the volunteers. If you use a green cover crop with slow development (like clover) herbicides are essential.

Permanent fallow

In this case it is generally recommended to sow a mixture of grasses and leguminous plants. Because of the regulation which forbids nitrogen fertilizer, a perennial legume is essential.

ECONOMIC EFFECTS OF SET-ASIDE

In this part the method of optimising the cost of the set-aside for rotational fallow explained. But, because of the new regulation in the Common Agricultural Policy, it is not possible to calculate the global economic effects of set-aside for the whole farm.

For the farmer who is obliged to set-aside land the strategy consists of minimizing the losses due to suppression of certain crops and to minimize the costs of the fallow.

To minimize the losses due to set-aside the farmer must choose fields to set-aside and crops to forgo. To do that the farmer must know the exact yield of each crop in each type of soil in his farm. Then he can calculate the gross margin in each case. Table 4 shows an example obtained from a farm with heavy clay soil located in Lorraine.

Table 4 : Gross margin for each crop and each type of soil in a Lorraine farm

Crops	Undrained fields	Drained fields	Average gross margin for each crop
Oil seed rape	4 300	4 700	4 500
Winter wheat	3 500	4 100	3 800
Winter barley	2 200	2 900	2 550
Average gross margin for each type of soil	3 333	3 900	

Then you rank the gross margin and choose to set-aside the crop-fields which have the lowest gross margin, up to an area double the set aside rate (for example 30 % if the rate of set-aside is 15 %). If necessary you can modify the rotation in the part of the farm set-aside to optimize the farm income. In the above case you can reduce winter barley and change a three year rotation to a four year rotation : oil seed rape/fallow/winter wheat/oil seed rape.

The second point is to minimize the costs of the fallow with as low inputs as possible and avoiding any effects on the following crop. Table 5 gives two examples of costs. It seems to be very difficult to reduce the cost below 600 to 700 FF/ha.

Table 5 : Examples of cost for rotational fallow

	Example 1 mixture perennial Rye grass white clover	Example 2 Pure Rye grass
Mechanisation cost	250	250
Seeds	220	170
Herbicide on the fallow	0	100
Herbicide to destroy fallow	220	200
TOTAL	**690**	**630**

In this example, we have considered that the fallow is sown after oil seed rape. You have to chop the crop residue, then, after a stubble cultivation, you can sow the fallow and roll the field to ensure adequate emergence. If you sow pure grass, it seems useful to use a selective herbicide. And you generally need a total herbicide to destroy the sward before the following crop.

CONCLUSION

The set-aside scheme has introduced a really new crop to Europe : fallow. To manage this new crop we have very little technical information. The knowledge of the old farmers who used fallow in the past is not very useful because they use it in an other context - generally the fallow was grazed and this is against the rules.

We have to develop research on this "crop" in 3 directions : the best sowing period ; drilling methods ; and physiology of emergence for different species in dry conditions.

We also have to choose species to minimize the cost of management (herbicides - cutting period) and better understand the impact of the fallow on the next crop : nitrogen management and weed control.

ACKNOWLEDGEMENTS

The authors thank A. FONTAINE from ITCF who do the flora identification on the experiment.

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INSTITUTIONAL ASPECTS OF THE LAND SET-ASIDE EXPERIENCE IN SPAIN

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ABSTRACT

Since 1988 the European Community has introduced two land set-aside schemes, specially designed to contain grain surpluses. Both are very similar, but differ in the duration of the land retirement (five years and one year). The results of these programmes in Spain have been quite different. While the five year plan can be qualified as an outright failure, with less than 80.000 ha retired after four years of application, the short term programme has developed very successfully in the first year of its application. An institu tional explanation of this apparent contradiction is attempted.

INTRODUCTION

Direct and indirect production controls designed to curtail surpluses are not an original idea of European agricultural policy makers. Quotas (direct controls on the produced quantities) and rationing of key production factors (mostly land set-asides) are the only means of reducing structural surpluses without abandoning price support altogether. Financial considera-tions were decisive for the introduction of the set-aside programmes in the European Community. The economic consequences of set-aside, especially the well known effect of delaying structural change, do not seem to have been considered very much in these decisions.

The five year European version of set-aside, which was introduced in 1988, is based on direct assistance to the farmers in order to offset the loses due to the land retirement.1

Due to the fact that the five year set-aside programme was not having any noticeable effect on grain surpluses, the Community introduced a short term one with similar aim in 1990. Unexpectedly, this yearly land retirement option is being much more successful than the old measure in Spain, in spite of the fact that they are hardly different from the point of view of their aims and way of application. The following contribution intends to explain these different developments from an instituional point of view. It is postu lated that Spanish institutions (agricultural bureaucracy, politicians and, up to a certain point, unions) did not favour the development of the five year programm and virtually ignored it. In doing so, they acted as predicted

1. The measure can take different forms, according to product specificity and kind of indemnization. A systematic study of the different kinds of set-aside in the USA can be found in: Böckenhof, E., et al. (1985): Produktions-begrenzenden Maßnahmen bei Getreide. **Schriftenreihe des Bundesministers für Landwirtschaft und Forsten.** Reihe A, Heft 317. Landwirtschaftverlag Münster

by the theories of institutional behaviour put forward by the economists of the Public Choice School.

THE FIVE YEAR SET-ASIDE PROGRAMME

Community dispositions and their application in Spain

The provisions of the set-aside programme apply to all agricultural areas where annual crops subject to market regulations of the Community are grown. All member states are obliged to offer these programmes to their farmers; participation for the farmers nevertheless is voluntary. The retired areas can be devoted to different ends. They can be laid fallow, forested or used for non-agricultural activities. The member countries must make sure that in the retired surfaces measures are taken in order to protect the environm ent and keep the area in good agronomic conditions.

The member countries must fix the amount of the premia. This amount must be determined according to the farmer s real losses due to participation in the programme. In the case of non-agricultural use of the retired area, meadows for extensive animal grazing or planting beans, peas or other legumes, the rules provide for considerable reduction of the premia to be paid 40 to 60 . Both the Community and the member countries are required to contribute to the premia. The Community contribution is bigger in the lower premium brackets.

A distinctive feature of the Spanish decree is that about 30 of the comarcas agrarias counties are exempted from the measure. Three quarters of the exempted zones are in the Autonomous Regions of Andalucía, Aragón, Castilla-León and Castilla_La Mancha. Another special feature of the Spanish set-aside is the extension of the reference period during which the areas to be retired are supposed to have been tilled. Spain requires a period of two years, instead of one year like the EC-legislation. These more exacting regulations makes it more difficult for the farmers to participate in the programme and could be interpreted as a bureaucratic obstacle to the develop ment of the measure.

The Spanish regulations provide that the premia are drawn up according to intensity of land use and location of the agricultural land to be retired, depending if its is placed in a socioeconomically depressed area or not. This regulation applies to rain-fed surfaces. Irrigated areas are classified according to three levels of irrigation intensity.

The Spanish premia cover the lower end of the possible range of payments. These maximize the EC-contribution at about 60% of the costs of the programme

Spanish application procedures are extremely complex; much more than is required in the EC-regulations. The completion of all the documents is diffi cult and time consuming for a farmer. These obstacles can be considered as a bureaucratic hurdle to the development of the programme in Spain.

APPLICATION OF THE MEASURE IN SPAIN

Geographical distribution of the retired areas

The Ebro-Valley and the south-easterly region of the Province of Toledo contain two thirds of the set aside area in Spain.2 The Ebro Valley covers a total area of 16.000 km2 in the provinces of Huesca and Zaragoza (Aragón). Grain is by far the most important crop in the region, covering almost 80% of the agricultural area. The valley of the River Ebro is a typical area for the application of the programme.

The region Toledo-Mancha is located south of Madrid and encompasses five counties ("comarcas agrarias") of the province of Toledo and the westernmost county of the province of Albacete. Both provinces belong to the Autonomous Community ("Comunidad Autónoma") of Castilla-La Mancha. The crop structure of these region is not so homogeneous as the one of the Ebro Valley Grain covers a little less than 50% of the agricultural area. Like the Ebro Valley, the precipitation is very low and yields are negatively affected.

Participating farms and farmers

Full time farmers which keep accountancy records and are members of cooperatives are more likely to participate in these programmes. This is probably due to the fact that farmers with those characteristics have a better knowledge of the economic and technical possibilities of their enterprises and environment, which is needed in order to estimate accurately the convenience of participating in a programme with carefully gauged premia like this one.

Regarding farm size, participating enterprises are bigger than average. Eighty five percent of participant farms are larger than 20 ha. In the area of Toledo 72% of the farmers have more than 100 ha. The average size for participating farms there is 467 ha, in the Ebro Valley is 230 ha and in Spain as a whole, 207 ha.

Characteristics of the set-aside

Permanent fallow is the most common set-aside option, followed by rotational fallow. However there are differences between the two regions. In the Ebro Valley both kinds of fallow together made up 94% of the retired area while in Toledo-Mancha fallow as a percentage of the retired area (82%) was under the Spanish average. But permanent fallow covers 69% of the retired area there, while rotational fallow naly accounts for 13%.

Growing of legumes and meadows dedicated to extensive animal raising also have some importance for the set-aside programme, especially in the area of Toledo-La Mancha. Non-agricultural uses and afforestation are not very popular as set-aside options among Spanish farmers.

Ninety percent of the farms in both researched areas have retired more than 30% of their agricultural land. Thirty percent of the participants retired their whole area. The Spanish farmers, when they participate in the programme, retire more than the minimal area required by the Community.

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2. The data in which the present section is based was obtained from application forms filled by Spanish farmers participating in the programme in the year 88/89

SHORT TERM SET-ASIDE IN 1991/92

Dispositions of the European Community and their application in Spain

This programme is very similar to the previously discussed five year one. The areas to be considered, for instance, are the ones which were tilled with annual crops subject to EC-market arrangements in 1990/91.

An important difference is that it it is possible to finance 100% of the premium through Community contributions. This kind of set-aside is not directly onerous to the national treasuries of the member countries. Participating farmers are also entitled to restitution of the coresponsibility levy they paid the preceding year. An important difference from the five year programme is that no economic use for the retired area is allowed.

In the Spanish areas exempted from the five year set-aside, which includes 30% of the Spanish "comarcas", only a maximum of 20% of the agricultural area of the farms can be retired. The grain area must be reduced at least 15%.

The criteria to draw up the different areas to scale amounts paid are the same as for the five year plan (depressed and non-depressed areas and three irrigation intensities). The environmental protection dispositions of the Spanish decree are literally the same as the ones of the Community dispositions.

The application of the short term set-aside (1991-92)

Both the number of applications and the retired area rocketed in comparison with the five year programme. In that first programme only 285 applications and 21.267 ha were approved in the first year. For the short term programme 13.000 applications and 983.647 hectares were registered between August and December 1991. 3 The geographical concentration of the retired areas under this programme in Spain shows a pattern very similar to the one of the long term programme.

Provisional results of a research project of the Institute of Agricultural policies of the University of Hohenheim suggest that participation in this programme is an interesting proposition for producers in marginal agricultural areas in Spain. The medium term set-aside looks, nevertheless, even more interesting, especially considering that a longer land retirement allows fixed costs savings in machinery and installations. Some test runs of mathematical models confirm this supposition.

FINANCIAL COMPARISON BETWEEN THE SHORT AND MEDIUM TERM PROGRAMMES

A comparison between both programmes leads us to the conclusion, that the five year programme would have allowed, from the point of view of the EC, noticeable greater savings than the short term measure. But that is clearly not the case from the point of view of the Spanish state. The following

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3. Our figures, directly obtained from the "Servicio Nacional de Producción Agraria" (SENPA), responsible for the programme, do not agree with the ones provided by the EC, which register only 250.000 ha. For our calculations we have used the Spanish information.

table summarizes the situation supposing a minimum and maximum surplus relief through the programme (Case I and Case II).

The short and medium term set aside in Spain

	Medium term	Short term
Market relief (t)		
Case I	17.225	813.225
Case II	61.668	2.268.132
Costs to the EC		
Case I	75 ECU/t	121 ECU/t
Case II	21 ECU/t	43 ECU/t
Cost to Spain		
Case I	104 ECU/t	------------
Case II	29 ECU/t	------------
Budgetary savings (EC)		
Case I	74 ECU/t	31 ECU/t
Case II	128 ECU/t	108 ECU/t

The failure of the medium term programme has cut the possible savings of the Community at least by a half. In our opinion, the reasons of this failure is to be found in institutional attitudes towards the measure in Spain.

INSTITUTIONAL INTERPRETATION OF THE OUTCOME OF THE SET-ASIDE PROGRAMMES IN SPAIN

The poor support for the 5 year set-aside, followed by the considerable development of the short term programme can be explained according to institutional considerations and following the theories of the Public Choice School of Economics.

The rational choice paradigm of traditional economic thought considers that economic policy making takes place through a process which maximizes a public utility function. Resource allocation is done according to economic rationality with institutions as a simple executing arm in this process.

The Public Choice School considers that institutions have a central role in the allocation process. There is not a public utility function available, but individuals within institutions behave as utility maximizers, exactly in the same way as economic subjects of orthodox economic thought (principle of methodological individualism). To interpret the conduct of officials in this way yields an accurate picture of the process of creating and executing economic policy. The differences between the recommendations of "good" economic policy of the rational choice paradigm and the decisions which are taken in the real world can be then better explained.

The main players of the policy making process are elected politicians, political appointees in the administration, professional bureaucrats, union officials and the public, both as simple voters or as members of organised interests groups. The behaviour of institutions is not guided by some altruistic and detached spirit, but is the result of the conflictin interest of the individual members of those institutions. The economic environment builds the background and sets the limits which bound the participants.

PLAYERS IN THE POLICY MAKING PROCESS

Voters share a common interest in increasing the welfare of the whole society. They are also divided into interest groups and prone to perceive these particular interests very strongly. The defence of particular interests is expressed through voting behaviour and through organisations such as unions and other kind of pressure groups.

Elected officials have an open interest in being reelected. Their behaviour will be dominated by electoral calculus. While in office, nevertheless, politicians are conscious of budget constraints and eventually must react to international pressure. Crises, however, can detach the politicians from their compromises with their constituency and give them temporarily more behavioural autonomy in the name of "superior interests".

The bureaucracy has been given a central role in the process of decision making by the Public Choice School. In the traditional economic streams, on the contrary it is only the executive arm of policy decisions and does not play a mayor role in shaping those decisions. Light was shed into the bureaucratic "black box" by the analysis of A. DOWNS (1967). DOWNS analyzes the behaviour of a utility maximizing agent within the framework of a bureau and studies the result from the point of view of the shaping of policies.

A bureau is a kind of organisation with some specific characteristics. It is large ("high ranking members know less than half of the other members") the majority of the members are full time employees and depend on the organisation for the bulk of their earned income and the major proportion of its output is not evaluated through the market. The organisations that administrate agricultural policies in Spain (and in any middle sized modern country) fullfil the conditions to be considered bureaus.

Having established that an agricultural administration has the characteristics of a bureau, it is possible to focus on some of the characteristics of utility maximising members of those organisations which explain its influence on the development of the set-aside programmes in Spain.

As already stated, members of organisations are also utility maximizers and try to icrease security, power, income and prestige within it. A good way to achieve these goals is to engage in superior pleasing conduct.

Superiors are very often political appointees; they are sensitive to the changes of the political fortunes of their elected partners. Through these mechanisms even the unelected bureaucracy is influenced by officialdom.

Functionaries are also susceptible to criticism of their activity because this can lead to loss of influence to competing bureaus. In order to cut possible criticism, bureaucracies develop an official version of the "whys" and "hows" of their activity. In the words of JOHN K. GALBRAITH, bureaucracy develops "a bureaucratic truth".

THE SPANISH SET-ASIDE UNDER A DOWNSONIAN APPROACH

The short-term set-aside developed very quickly in Spain; on the other hand, the medium term version was a complete failure. Available evidence suggests that, from the point of view of individual farmers in some marginal areas with low productivity, both set-aside programmes are an interesting proposition. For a utility maximising farmer, the five year programme is even more interesting than the short term one. The savings to be made by the Community were bigger with the five year programme than through the application of the short term measure.

The limited diffussion of the five year programme can be ascribed to the attitude of Spanish institutions. Information was withheld. Union offices and outposts of the agricultural administration, usually keen to promote programmes and subsidies among farmers, were reluctant to speak about or even mention this one. Also an enormous amount of red tape was involved in completing forms for the five year programme.

The budgetary constraint was surely a central cause of the resistance of the politicians to the five year programme. Taking into account that Spain contributes only 8% of the Community budget, for the Spanish treasury it is much more convenient to pay for the fraction of intervention costs and export support than for the member's country share of the set-aside premia. Politicians were not eager to allocate scarce budgetary resources to a highly controversial programme, especially when those resources could be used to hand out much more palatable subsidies. 5 Through the described mechanisms of loyalty to superiors, the whole administration closed ranks to avoid possible criticism which could diminish the popularity of elected officials or be used by competing organisations to tear away influence from the hands of the bureau. In the case of the one year set-aside ther is no national contribution to the premia; no need to worry then about accusations of profligacy with public funds. The measure was therfore not obstructed.

The attitude of union officials towards the programme did not differ much from the one of the administration. Union membership is not very high among Spanish farmers, and union officials are understandably worried about constituency losses. The medium term set-aside can push farmers out of the land in marginal areas, weakening the unions even further.

Opposition against the measure is shaped around a stated worry about public welfare. The most common stated arguments against it fall within three categories:

a) socioeconomic consequences. Depopulation of the countryside, either through direct effects of the programme or indirectly destroying backward and forward linkages of agriculture.

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5. In 1991 subsidised investment under Royal Decree 808, one of the most popular EC programmes was stopped, probably due to lack of funds.

b) negative ecological consequences.

c) administrative aspects. Impossibility to control honest participation in the programme, atleast with the available staff.

Even when these arguments seem to be justified in many cases, it is also possible to recognize the development of "bureaucratic truth". Its basis is a plausible one, and officials and union leaders sustaining these points of view are surely honest about them. But it is also very convenient to justify the blocking of an inconvenient programme at administrative level. It is important to notice that some important negative consequences of the measure -for instance, the freezing of structural change- are never mentioned even in areas where this could be a problem. This confirms the fact mentioned by JOSLING and WAYNE MOYER (1990), that policy decisions are usually taken with inmediate financial considerations in mind, while efficiency criteria play only a secondary role.

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CHANGES IN LAND USE PATTERNS IN ALENTEJO, PORTUGAL UNDER EC SET-ASIDE POLICY: IMPLICATIONS FOR AGRICULTURAL SECTOR AND REGION

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ABSTRACT

First the specific regional situation of the Alentejo is explained as an example of an extensive, but economically important dryland agriculture in Southern Europe.
Changes in land use patterns are estimated in several policy experiments performed on a linear programming model. The model is based on regional representative farms, including traditional and innovative technologies. Policy experiments cover set-aside and extensification measures.
Based on changes in land use patterns at the representative farm level, economic and social effects are estimated for the agricultural sector and the region. Effects on the rural labour market and forward linked commerce are further discussed. The results show that set-aside policy, geared to intensive cropping systems in Middle and Western Europe cannot be transferred to extensive systems in the South without significant negative impacts on rural economy. Extensification policies including premiums for already existing extensive systems would be more appropiate. Furthermore a regionalization of agricultural policy would be necessary.

INTRODUCTION

The objective of this analysis is to identify potential sectoral and regional effects of CAP surplus-controlling measures. Set-aside was implemented in Portugal only shortly before the CAP-reform decision. Up to the end of 1994 Portugal is not obliged to initiate either the 5-year set-aside program, nor the extensification measure package. Due to this fact, estimations about their potential effects after 1994 have to be done by "ex-ante" model experiments. Only the 1-year set-aside program has been implemented, but its evaluation is also limited to the same methodology.

THE REGION

Alentejo covers 27.290 km^2 and is the largest of Portugal's regions and the most important national cereal production area. Agricultural conditions can be classified as poor to average, and some 20 % of the working population is still occupied in agriculture. Dryland agriculture is dominated by extensive cereal production systems, sheep and cattle production and some use of cork trees ("montados"), which together represent about 47 % of regional agricultural gross product (Marques, 1991).

The average productivity of dryland cereal production is about 1.6 t / ha; on best soils yields up to 4 t / ha can be reached. Most extensive locations work on 1.2 t / ha in rotations including a high number of fallow years (1-7 years). The average area of farms is about 38 ha. Most dryland production is on farms with areas over 300 ha arable land, which are worked by hired labour.

METHODOLOGY

The analysis was based on a linear programming model adjusted to local production conditions. Regionally representative farms had been modelled for two important subregions (Cary, 1985). The first is an area of the best regional soils (clay soils of Beja district) with relatively intensive cereal cropping; the second an area of low to average productivity in cereal production associated with sheep and / or cattle ranching (Évora district). Differences in resources available to the model farms and the use of traditional versus innovative technologies were further considered.

Price and policy frameworks for the year 1991/1992 were assumed for the reference solution of the model. Access to different policy measure packages was offered in model experiments ("scenarios") to representative model farms. The results of model runs - mainly the land use pattern - were used to derive several other indicators: potential acceptance of measures by farmers, potential impact on farm income, quantities and type of required production factors and production. A final look was taken at budget effects.

Policy scenarios were modelled for the 1-year set-aside program (EEC Nr.2069/91), the 5-year program with all possible options offering premiums of 100 or 300 ECU and for the extensification measure package (DGMAIAA, 1992; Ekelmans & Smeets, 1990a;Ekelmans & Smeets, 1990b). Experiments on the CAP-reform were also done, but results are no longer relevant due to reform decisions in May 92, which have not been considered.

RESULTS

The potential changes in land use are summarised in Table 1.

TABLE 1. Set-aside area as % of total arable area and as % of market regulated product area in the previous year.

	1-year set-aside (90 ECU)	5-year set-aside (100 ECU)	5-year set-aside (300 ECU)
as % of total arable land	7.5	10.9	24.9
as % of area with EC market reg. products	15.4	23.7	62.3

Over all types of representative farms, 7.5 % of the total arable area would go out of production with the 1-year set-aside package. The 5-year set-aside, with a premium of 100 ECU would take out 10.9 %, and with 300 ECU as much as 24.9 %. The data concerning the decrease in the area planted with market regulation products is shown in the lower part of the table. The relationship between the two issues is due to the relatively large number of fallow years in the local production system.
The 5-year set-aside program would not be accepted by a part of the model farms, if offered with the low premium of 100 ECU / ha. Offering a 300 ECU premium, all types of farms would participate, some up to 100 % of their reference area for set-aside. All representative farms would prefer the option of rotational set-aside. The options of fallow use for extensive livestock production or protein crop production were not competitive in any case. The extensification program would be accepted by all model farms.

The effects on farm income and therefore the relative attraction for farmers are shown in Table 2.

TABLE 2. Gross income change (%) from joining policy measures by farms of different production systems.

System	1-year set-aside (90 ECU)	5-year set-aside (100 ECU)	5-year set-aside (300 ECU)	extensification
intensive cereal system	+ 7.6	+ 3.6	+ 21.6	+ 40.1
extensive cereal and livestock system	+ 4.3	+ 7.5	+ 65.5	+ 56.8

The 1-year set-aside program would be particularly attractive to farm types with high cereal production, which had to pay considerable amounts of co-responsibility tax in the previous year. In some special cases the sum of the set-aside premium and restitution of co-responsibility tax would mean a total premium of about 250 ECU / ha. Some farm types (extensive crop production associated with cattle ranching) would not join the program. Anyway, for traditionally managed farms this option would be more attractive than for innovative ones.

Table 3 gives an impression of the potential decrease in cereal production caused by different measures. The values are given as an average over all farm types, including those which would not join the measure.

TABLE 3. Decrease of cereal production in different production systems (%).

System	1-year set-aside (90 ECU)	5-year set-aside (100 ECU)	5-year set-aside (300 ECU)	extensification
intensive cereal system	9.4	8.6	35.9	20.0
extensive cereal and livestock system	10.1	12.0	51.9	20.0

Searching for the cheapest measure from the EC budget viewpoint, the costs of every tonne reduction in cereal production was estimated, and Table 4 shows the results.

TABLE 4. Costs per tonne reduction in cereal production (ECU).

1-year set-aside (90 ECU)	5-year set-aside (100 ECU)	5-year set-aside (300 ECU)	extensification
137.6	126.0	258.7	442.6

The results show a clear preference for offering low premia, which would only be attractive for marginal cereal production areas. Extensification would not be attractive from a budgetary point of view.

Table 5 gives an impression of how regional labour and input markets would be affected by implementation of the analyzed policies.

TABLE 5. Decrease in factor requirements (%).

	1-year set-aside (90 ECU)	5-year set-aside (100 ECU)	5-year set-aside (300 ECU)	extensification
unskill. worker	0.7	3.7	5.9	7.2
tractor driver	6.1	8.1	20.2	1.9
nitrogen	7.6	8.3	27.6	miss.val.
herbicides	5.7	7.2	27.0	miss.val.

As shown in Table 5, implementation of these policies will cause a relative decrease in chemical inputs. The factor demand decrease through extensification was not calculated, but would probably be above 50 % for chemical inputs and about 90 % for seeds.

DISCUSSION

Set-aside policy measures would certainly increase farmers' incomes and also decrease cereal production. For a region where most farms are run with hired labour, it would be a bad policy from the viewpoint of social justice to transfer income to landowners and make the rural labour force redundant. Due to its public budget situation, Portugal would be trying to stay on the lowest premia for these measures in any case. The low premia would mainly take subregions with less productive cereal systems out of production. To make set-aside measures attractive to better locations, where technical progress will continue, premia will have to increase year by year.

Overall, set-aside policies will reduce land use and affect the regional economy mainly in subregions of marginal productivity. Due to their low cereal productivity, these locations would be highly affected without being mainly responsible for EC production surpluses. These policies have been planned against the background of Middle to West European intensive agricultural systems where agriculture is of less regional importance compared to southern Portugal. A regionalized extensification measure package - including premia for already existing extensive land use systems - would be better adapted in the Alentejo case.

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SET-ASIDE AND ORGANIC FARMING

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ABSTRACT

The management constraints that have been applied under the rules of the five year set-aside scheme have afforded farmers the opportunity to consider a conversion to organic production within the rules of set-aside management. This paper examines the physical and financial implications of using set-aside as a route to conversion to organic production. These implications are examined on a General Cropping farm, using a financial model that calculates the profitability of a business as it progresses through its conversion to organic production. A calculation of current profitability is made, and the performance of the business through conversion is compared with its opening level of performance. The organic policy chosen is one that complies with Soil Association guide-lines and rules. The physical and financial effects of a rapid conversion to organic production are assessed both with and without the benefit of set-aside receipts, and compared with a longer term approach to conversion without the benefit of any set-aside receipts.

INTRODUCTION

The management constraints enforced under the five year set-aside scheme have met the basic management requirements of a conversion to organic production under the Soil Association rules. This means that a business could use the payments available under the five year set-aside scheme, to help subsidise a conversion to organic production. Detailed planning has been required in such cases to permit the scheme to be used, as a mixture of both rotational fallow and permanent fallow is often required.

The level of use a business could make of the set-aside scheme has been highly dependant upon the area of land that was originally registered as relevant arable land in 1988. This paper examines the effects on a business that is likely to have the opportunity of using set-aside for organic conversion, i.e. one that would have had a significant area of relevant arable land in the registration year.

The financial effects of the conversion have been assessed using a computer model that calculates the change in profitably of the business over the conversion period.

THE COMPUTER MODEL

The model is a spreadsheet (Supercalc) based calculator, that requires details of the cropping and stocking policies of the business over nine years as the business changes over to organic production. The model then calculates the gross profit of the business in each year. Estimates of capital requirements and personal expenditure are then included in order that the interest charges to be incurred by the business can be calculated. These interest charges are then deducted from the gross profit to derive the net profit of the business in each year.

The main objective of any agricultural business is to increase the net worth of the business over time, which can only be achieved by the business achieving a net profit in excess of the personal drawings required. The model calculates the net worth of the business as it changes from year to year as a direct result of the trading that the business undertakes. The net worth thus calculated is compared with the net worth that would have been generated had the business remained in conventional production.

The model has been used to compare different methods of conversion to organic production, including the use of set-aside as a financial assistance to a rapid change to an organic farming policy.

SET-ASIDE MANAGEMENT AND ORGANIC CONVERSION MANAGEMENT

The organic conversion requirements.

At its most basic level the requirements for the conversion period can be simply described as a period of two years during which the land does not receive any prohibited treatments. Providing this basic criterion is met, then the land so treated will generally be considered to be of organic status at the end of the two year period, and organic crops of symbol standard can then be grown on that land if they are grown to the organic guide-lines laid down. A conversion plan has to be agreed in advance with the organic standards body at the outset, and set-aside has been used in such agreed policies in the past.

At a more sophisticated level, the producer is encouraged to consider a wide variety of factors in the conversion stage management, including : rotation development, manuring systems, appropriate cultivations, non-chemical weed control, pest and disease control, and soil improvement measures (N. Lampkin *et al* 1986). The conversion period has been viewed as a time during which the skills and techniques of organic farming can be mastered and developed (N. Lampkin *et al* 1986). The conversion period has also been recognised as a stage towards organic production where yield reductions are expected without the benefit of price premia, thereby reducing margins and profitability (N. Lampkin 1986, D. Ramsay 1991, M. O'Mara 1991).

The set-aside requirements

The rules for the management of set-aside land did not allow the use of what would be considered to be prohibited products under an organic conversion. The use of insecticides and fungicides was forbidden and herbicides could only be used with special consent. The use of inorganic fertilisers was also prohibited. A cover crop had to be established, and clover could be a constituent part of any cover crop, (thereby preventing leaching of nutrients and allowing a possible build up of nutrients.) (DAFS SA6 1988, DAFS SA1 1990).

Whilst these restrictions were generally in line with organic conversion requirements, other restrictions were not so compatible. The exclusion of the use of animal manures and slurries would be considered a limitation. Similarly the later introduction of the grazed fallow option permitted only limited grazing practices.

Furthermore the scheme militated against the opportunity for the producer to acquire the skills and techniques considered valuable for the successful conversion of the business.

The use of set-aside to assist conversion

Only those farms with a significant area of relevant arable crop in the base year for registration would have found this scheme to be of value to them in terms of a conversion to organic production. Farms with small areas of relevant arable crop would not have sufficient area suitable for set-aside to be able to make a significant impact on either the speed of or the cost of conversion. Those farms with a large proportion of their land in relevant arable crop production in the base year will be those who can make most use of the set-aside scheme, and will generally speaking be the farms that are the most difficult to convert to organic production because of the high proportion of arable cropping within their rotation.

The use of set-aside will permit a more rapid conversion, along with a set level of financial support and a reduced level of input costs. The total area registered in relevant arable crops could be converted within three to five years, and both rotational and permanent fallow options could be used to achieve this, although the restrictions of the set-aside scheme would force the producer to introduce a very carefully considered field by field plan. The variable costs of the conversion would be low, but large savings in the fixed costs would not be considered possible as the machinery and fixed equipment would have to be retained and maintained in preparation for the commencement of organic production.

A quick conversion to organic production using set-aside would not necessarily permit a quick establishment of a good organic rotation, with the soil improvement and fertility building properties considered essential to organic production (Lampkin *et al* 1986), being largely absent. Indeed it could be argued that a business would have obtained organic status for its land as a result of a set-aside conversion, but still required a further period of conversion before its organic policy potential could be achieved, and the producer had mastered the skills considered important.

FINANCIAL EXAMINATION OF EXAMPLE FARM

General Cropping Farm

A general cropping farm has been chosen as an example for conversion, with a rotation that includes rotational grass and a significant level of livestock production. The farm is 140 ha in size and is predominantly grade 3 land (as defined by the Macaulay Land Use Research Institute), and has approximately 35 % of the arable land in rotational grass. The farm is assumed to have adequate buildings and machinery for the conventional rotation. The conventional and organic farm policies along with yields and prices are given in table 1.

TABLE 1 . Conventional and Organic Policies

	Conventional Policy			Organic Policy		
	Area ha	Yield t/ha	Price £/t	Area ha	Yield t/ha	Price £/t
Winter Wheat	30	7.4	105	25	5.0	160
Winter Barley	10	6.2	95			
Winter Oil Seed Rape	10	3.7	270			
Spring Barley	10	4.9	114			
Spring Barley (u/sown)	20	4.6	114	20	3.5	130
Potatoes (Ware)	10	33.6	73	10	20.0	160
Grass	50			60		
Spring Oats				20	4.0	170
Swedes (shopping)				5	29.0	130
	No.	Sale Weight kg	Price p/kg	No.	Sale Weight kg	Price p/kg
Winter Finished Steers	100	535	115	80	509	130
Winter Finished Heifers	35	450	110			
Winter Stored Heifers	100			100		
Summer Finished Heifers	100	452	110	100	457	120
Gross Output (£)	121735			128750		
Gross Margin (£)	72350			74212		
Fixed Costs (£)	40351			41201		
Gross Profit (£)	31999			33011		

The organic policy chosen is marginally more profitable than the conventional policy to the gross profit level, mainly as a result of the inclusion of a high gross margin crop such as shopping swedes. Gross profit is the margin created by the business that is available to meet the interest charges of the business.

Three field by field conversion programmes have been calculated for the farm on the basis of fourteen 10 ha blocks. The slow conversion programme attains full organic status in year 9, whilst the set-aside programme achieves full organic status by year 4. The quick conversion programme achieves the conversion by year 3.

The slow conversion programme uses the grass break in the rotation as the conversion crop, where the quick conversion programme simply takes the entire rotation and converts each crop within two years (i.e. each crop in the conventional rotation is converted.). The set-aside conversion programme uses the three year option under the five year scheme to convert all the land, except those non arable fields which are converted using the grass break in the rotation. The financial results calculated for each conversion programme are given in tables 2 and 3. :

TABLE 2. Annual Net Profit for conversion programmes

Year	Slow (£)	Quick (£)	Set Aside (£)	No Change (£)
0	20031	20031	20031	20031
1	16033	-12277	-2733	21234
2	16528	-14900	-5761	22582
3	22453	16585	-13798	24092
4	23481	17426	15393	25783
5	24227	18367	16290	27677
6	28619	19121	17245	29799
7	22716	20265	18114	32174
8	30482	21497	19088	34835
9	34796	22976	20306	36966

TABLE 3. Cumulative Net Worth for conversion programmes

Year	Slow (£)	Quick (£)	Set Aside (£)	No Change (£)
0	193031	193031	193031	193031
1	199046	170753	180298	204265
2	205591	145853	164537	216847
3	218044	152438	140739	230939
4	231524	159864	146132	246723
5	245801	168231	152422	264400
6	264421	177352	159667	284199
7	277137	187617	167781	306373
8	297619	199114	176869	331208
9	322415	212090	187176	358174

DISCUSSION

Net Profit Changes.

The calculations presented indicate that the slow programme for conversion to organic farming is the least costly and does offer the most acceptable approach, given that it also allows the producer to gain the benefits previously identified (Lampkin et al 1986).

The aim of the quick conversion is to give the business the earliest possible start to organic production in order that it may benefit from the organic premia, available for symbol standard produce, as early as possible. A large fall in profit is calculated initially, and a net loss would be expected for the two years of the conversion period, when enterprise gross margins are reduced as a result of lowered yields without the benefit of a product premium. Once the business is in full organic production, however, the profitability returns to the business, but higher interest charges (arising from the earlier losses) mean that the net profitability remains below that of the slow conversion programme.

The set-aside conversion programme provides additional income in the form of the set-aside receipts, which should help to offset the cost of the quick conversion. The losses incurred during the first two years of the conversion are reduced, and the profitability of the business is some £18,683 greater in the first two years of the set-aside conversion when compared with the quick conversion. In the third year of the set-aside conversion programme the business makes a greater level of loss as a result of higher interest charges. In the same year (third), the quick conversion programme has returned to profitability, and the difference in the level of profit is calculated to be £30,383, in favour of the quick conversion. Although the business achieves organic status in year 4, the high levels of interest the business has to bear means that the set-aside conversion programme has a slower rate of increase in profitability and the lowest overall level of profitability by year nine, of the three systems.

In order for the set-aside policy to be comparable with the quick conversion policy the set-aside receipts would have to average £271 per ha over the three years used for permanent set-aside.

In order for the set-aside option to provide the same level of profitability as the slow conversion programme, the set-aside receipts would have to average £509 per ha over the three years used for permanent set-aside.

Cumulative Net Worth.

If the profitability of the conventional policy can be maintained over nine years then the greatest level of net worth is achieved by the continuance of the conventional policy. The slow conversion programme will allow the business to suffer a net drop of £35,759 (10%) in net worth by year nine. This does not represent a serious erosion of net worth but the conversion could only be attempted by a financially well structured business.

By contrast the quick conversion programme would suffer a drop in net worth of £146,084 (41 %), and the set-aside would suffer a drop of £170,998 (48 %). Such levels of capital erosion would not be considered acceptable, and the conversion by either of these routes would result in a poorly structured business that would be unlikely to survive.

In the example described there has been no additional capital required for additional buildings or machinery, as would be the case in many organic conversions where a livestock enterprise has to be introduced.

CONCLUSIONS

A change to organic production can be achieved with reduced levels of net worth erosion using the slow conversion programme, providing high levels of capital are not required for fixed equipment.

A rapid conversion policy aimed at obtaining the organic premia for produce at the earliest possible stage incurs high penalties in terms of net profit and net worth erosion, and cannot be considered a financially prudent method of conversion.

The set-aside scheme does not appear to provide a suitable vehicle for assisting this rapid conversion. Indeed the limitations on the use of set-aside (rotational versus permanent fallow) can cause the process to be more expensive if undertaken in this manner. Significant increases in the level of payments received for set-aside would be required to make it a suitable programme to improve the profitability of conversion to organic agriculture. A change in set-aside management rules would also be required to allow the producer to achieve the other goals of the conversion process.

ACKNOWLEDGEMENTS

The author thanks the Organic Farming Centre, funded by Safeway, Scottish Enterprise and the European Commission, which supported a series of reports into organic conversion and the development of the model.

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THE IMPACT OF THE EUROPEAN COMMUNITY'S SET-ASIDE POLICY IN GERMANY

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ABSTRACT

The German government has been an enthusiastic supporter of the set-aside scheme. This is reflected in the relatively higher levels of subsidy offered to German farmers to set-aside their arable land compared with other farmers in the European Community. Over the last four years roughly 300,000 ha have been set-aside in the former West Germany, and since 1990 a further 600,000 ha have been set-aside under a modified programme in the new states of the former East Germany. Currently over 7.5% of arable land in the United Germany is set-aside.

INTRODUCTION

Although over half of all set-aside land in the EC is located in Germany, the country continues to have a self-sufficiency in cereal crops of between 115-120% (the average for the EC 12 is 121%) (Uhlmann, 1991). Against this background, this paper examines the motives for farmer participation in the set-aside scheme and the resulting effects upon the farm business and levels of production. This paper draws on extensive farm level research on set-aside policy conducted by the authors between 1988-1991 in the states of the former West Germany (Jones, 1991; Fasterding et al.,1992). Some 1800 businesses were sampled in a general survey and a further 160 detailed interviews were conducted in northern and south-western Germany. Together they represent the biggest survey on set-aside policy undertaken in the EC.

GERMAN FARMERS' MOTIVES FOR PARTICIPATION IN THE SET-ASIDE SCHEME

Up until the recent MacSharry proposals set-aside policy was viewed as a voluntary scheme for farmers. Consequently, it enabled a variety of adjustments and responses on the part of farm businesses. The withdrawal of land from production is the end product of a complex set of issues relating to household structure, succession plans, competing demands for time, alternative income opportunities, and the health of the farmer or of other family members on whom the continued survival of the farm business directly or indirectly depends.

The premiums to set-aside land have different utility functions for different farm businesses. For example, one can discriminate between those who can afford to participate and those who cannot afford not to. Although it is not our intention to examine further this point in this paper it is important to recognise that there are considerable differences in the way in which farm businesses use the set-aside grants. For smaller farm businesses, participation in the set-aside scheme may be the only alternative to being forced out of the industry and as such may be incorporated into the overall strategy for the farm businesses' survival.

Set-aside premiums are particularly important for those farm households about to embark upon or wishing to expand non-agricultural activities. As an individual strategy for securing their livelihood in the face of continuing structural change, German farm families are increasingly making use of various forms of part-time farming. This confirms the view of Munton and Marsden (1991, p115) that " it may be the family's labour skills in meeting the opportunities presented by off-farm employment or on-farm non-food enterprises which will permit continued occupancy of the land." Set-aside premiums play a major facilitating role within this process. Our research has shown that those farmers running their businesses on a part time as opposed to a full time basis are more likely to participate in the set-aside programme.

Issues relating to land ownership are also important in the assessment of the impact of the set-aside programme in Germany. The renting of land may well be for relatively short periods (normally not longer than 12 years), and farmers in the middle of such arrangements may be unable (or unwilling) to secure contractual extensions. Our investigation of those businesses participating and not-participating in the set-aside scheme has shown that the percentage of rented land in the holding is lower among the former than the latter group.

Major criticism of the set-aside scheme has focussed upon the quality of the land enrolled in to the scheme. Although the level of premium offered to German farmers to set-aside land takes some note of the variations in soil quality (known in German as Ackerzahl), it does not relate closely to actual yield indices. Our research has demonstrated convincingly that it has been land with lower yields that is more likely to be set-aside.

Non-livestock farm businesses are also more likely to participate in the set-aside scheme than other businesses. Our survey reveals that businesses participating in set-aside have a lower percentage of pasture land than those not participating.

One might assume that those farm businesses with elderly occupiers are more likely to participate in the set-aside scheme than those with younger occupiers or those farm businesses with secure successors. This thesis holds true in Germany. Our research has revealed that participation in the set-aside scheme may be the first or latest stage in the running down of the holding before retirement.

INCOME EFFECTS

One of the most important aims for the farm business is to maximise income. This section describes the income effects of participation in the set-aside programme. Our survey has unfortunately not been able to consider the entire economic situation of individual farm households since this would require detailed questionning of all income-earning members. Our quantitative analysis is restricted to the income effects on the arable business. Set-aside participation also has other icome adjustment effects, for example, reductions in labour costs, the increase or intensification of livestock enterprises or the cultivation of alternative crops.

For individual farms our research has focussed upon the average yields and total harvests for various arable crops before and after participation in the set-aside scheme (1987/88 and 1989/90 respectively). Total income has been calculated using the average farm gate price and by deducting variable costs (see Weischauser and Bokelmann, 1988). Assigning the variable costs to the production process for each farm business has depended upon the responses of farmers regarding their average actual yields. From these we have been able to estimate the gross margin for marketed arable crops. However, it must be noted that these have not been calculated on the basis of individual farm prices and variable costs. Only rough estimated values for the gross margins on individual farms could be calculated. The use of constant product prices and yields both for 1987/88 and 1989/90 has nevertheless guaranteed that the effect of the set-aside of land can be assessed more precisely.

The gross margins for the set-aside of land were obtained using the set-aside premium minus the costs of seeds and maintenance for the set-aside land. The costs of soil preparation and land maintenance are set at a fixed rate. For rotational fallow they are 200 DM/ha/year, and for permanent fallow (where only one opeartion is required over the five-year period) they are 90 DM/ha/year.

The gross margin for each arable crop and for every set-aside parcel have been summated for each farm business. Added to this sum is the socio-economic income and the additional compensatory payment. A total gross margin for the cultivation of marketable arable crops and set-aside has been calculated. This sum was divided by the total arable hectarage and the area set-aside.

Results of the gross margin calculations as well as the average set-aside subsidies/set-aside ha are considered in Table 1. It shows that the set-aside participant, who has chosen the permanent fallow option had a gross margin of 1183 DM/ha on the farmed arable land in 1987 (the year before the introduction of the set-aside policy). For those farmers who had chosen the rotational fallow option the figure was 1280 DM/ha and 1437 DM/ha for the non-participants in set-aside. Since participation the respective figures are 1256 DM/ha for permanent fallow (6% higher than the previous year), 1310 DM/ha for rotational fallow (2% higher), and 1565 DM/ha for non-set-aside participants (9% higher). Since constant yields, prices and variable costs have been used, these variations can only be explained by increases in the share of crops with higher yields in the crop rotation.

Most participants in the set-aside scheme have claimed that cereal yields were lower on their set-aside parcels than the rest of their arable land. This has been used to calculate a second variation in the gross margin for 1989/90. It was assumed that this deviation for average cereal yields could be transfered to other arable crops on the farm. If higher yields on non-set-aside land are taken into account, the average gross margin is increased to 1337 DM/ha for permanent fallow and 1361 DM/ha for rotational fallow participants.

Using a differentiation according to gross margins on set-aside and non-set-aside land the average gross margin obtained by permanent fallow participants on non-set-aside areas was 1684 DM/ha (42% higher) and on set-aside parcels 975 DM/ha(18% lower than the previous year). For rotational fallow participants the figures were 1574 DM and 880 DM/ha (23% higher and 31% lower respectively). Although the average set-aside premium/ set-aside area was 10-11% lower than the average gross margin per ha of arable land in 1987/88, the replacement of lower yielding arable crops from the rotation series led to an increase in the gross margin on the non-set-aside parcels of participants which was above the level of non-participants. Therefore the lower gross margin on the non-set-aside land could be over compensated.

FARM ADJUSTMENTS

The amount of necessary work operations will be reduced as a result of the reduction in farmed arable land. This has been shown in our research through a comparison of the participating and non-participating farm samples. For those farms where a part of the holding has been set-aside, and work time has been reduced, the household has attempted to maximise its total income by members of the farm household seeking or intensifiying their non-agricultural income sources. However, our research has shown that in 1989, one year after the introduction of the EC programme, there was little difference in the percentage of participants and non-participant households who had been able to secure or increase alternative income sources. This may be explained by the relatively short time period in which such alternative activities could have been secured or indeed the restricted employment opportunities available.

Another adjustment to the reduction in work load, may be the introduction of intensive production enterprises such as vegetables or strawberries, or more time and effort devoted to beginning or increasing livestock enterprises on the holding or the use of one's machinery on other farmers'holdings. However, our analysis has shown no significant difference between participating and non-participating farmers on these issues.

DECREASES IN PRODUCTION

In 1991 despite the existence of a set-aside scheme some 4.4 million ha in West Germany and 2.1 million ha in the former DDR were under cereal crops. Over 39 million tonnes of cereals were harvested (Table 2). Our research in 1989/90 of set-aside participants showed that 31% had intended to grow wheat on the now set-aside parcels, 49% intended to grow rye, barley, oats and cereal fodder, and a further 4% corn including corn cob-mix. Thus approximately 85% had intended to cultivate cereals. Without set-aside some 254,000 ha more cereals would have been cultivated in 1991 in West Germany and a further 508,000 ha in the former DDR.

Our survey also questionned both participating and non-participating farmers on their cereal yields. Differences in yields between set-aside and non-set-aside parcels were also investigated. On average, cereal yields were 16.5% lower on those parcels selected for set-aside compared to the rest of the cereal hectarage. Using this figure we have been able to estimate that set-aside has led to a fall in cereals production of 1.3 million tonnes in West Germany and 2 million tonnes in the former DDR. The reduction in the cereal hectarage as a result of set-aside is around 10% and we estimate that in 1991 this led to only a 7.8% fall in the cereal harvest in Germany.

The internal consumption of cereals in Germany in 1990/1991 has been estimated at 32 million tonnes (Uhlmann, 1991). Without set-aside the level of self sufficiency for cereals would have been approximately 125% and this would have meant an excess of 10 million tonnes production over consumption.

The complete removal of this overproduction would have required the set-aside of between 2.3 million ha of cereal land, that is 31% of the cereal hectarage.

In 1991/1992 roughly 750,000 ha of arable land are set-aside in Germany. This figure is 12% lower than that for the previous year. While the area set-aside in West Germany continues to increase, the former DDR is witnessing a reduction in its set-aside area. Overall this has led to a reduction in the percentage of arable land set-aside in the united Germany from 7.5% in 1991 to 6.6% in 1992.

For 1991/1992 Uhlmann has estimated an increase in the internal consumption of cereals in Germany to around 33.4 million tonnes. However, with a reduction in the area set-aside in Germany and a further increase in cereal yields predicted, a much higher level of cereal production is expected. A substantial reduction in the level of over production is not envisaged this year (Uhlmann, 1991).

CONCLUSION

This brief paper has emphasised three key points about the impact of the EC's set-aside policy in Germany. Firstly, farmers have participated in the set-aside scheme when the level of premium has been sufficiently high to cover their costs and/or where the premiums offer opportunities which allow the continued survival of the farm business by enabling it to match up internal demands (eg changes in the farm household) with external circumstances (eg changing policy environments). Secondly, and leading on from the above point set-aside policy can be regarded as a disguised form of welfare payment which allows smaller farm businesses to remain in the industry when otherwise they would have been forced out. Thirdly, we have demonstrated how the set-aside scheme has been unable to tackle effectively the problem of over production of cereals in Germany.

TABLE 1. Average gross margins and set-aside subsidy of participants and non-participants in the set-aside programme

	Permanent Fallow	Rotational Fallow	Non-Participants
	(DM/ha)	(DM/ha)	(DM/ha)
Gross margin 1987/88	1183	1280	1437
Gross margin 1988/89	1256	1310	1565
Gross margin 1989/90 (high)	1337	1361	-
Gross margin non-set parcels 1989/90 (high)	1684	1574	-
Gross margin set-aside parcels 1989/90	975	880	-
Set-aside subsidy 1989/90	1060	1144	-

TABLE 2. Reduction in cereals production through set-aside 1991

	German States		
	West	East	Total Germany
Cereal area (1000ha)	4430	2133	6563
Cereal yields (t/ha)	6.23	5.47	5.95
Cereal harvest (million t)	27.6	11.7	39.3
Set-aside area (1000 ha)	300	533	899
(of which cereal land)	254	508	762
Cereal yields set-aside land	5.17	4.57	4.32
Pot cereal harvest set-aside land (million t)	1.3	2.0	3.3
Act.cereal harvest(million t) (inc. pot harvest set-aside)	28.9	13.6	42.6

ACKNOWLEDGEMENTS

Dr A. Jones' research on the impact of set-aside in Germany is funded by the British Council (ARC programme) and the Anglo-German Foundation.

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SHOULD WE SET ASIDE SET-ASIDE?

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ABSTRACT

The use of land diversion in European agricultural policy changed in May 1992 from being a fringe, voluntary, experimental instrument to a central part of bureaucratic manipulation of output of the major land-using arable crops. It is argued that production control objectives are misguided and set-aside is an inefficient way of controlling production. It is also suggested that set-aside will not help achieve the other objectives sought of budgetary cost reduction and farm income stabilisation and support. Furthermore, additional actions will be required if it is to contribute to environmental amelioration. Half a century of experience of land diversion in the US supports these conclusions and further suggests that it is extremely difficult to extricate farmers from set-aside once it is started. The paper concludes by suggesting how to reduce the more undesirable effects of set-aside.

I INTRODUCTION

As part of the 1988 'Reform' of the Common Agricultural Policy (CAP) it was decided, mostly at the insistence of Germany, to compel each member state to introduce a set-aside scheme which would be optional for individual farmers. It was clear from the outset that whilst some member states (eg the UK) saw this as an accompaniment to cutting prices, others (eg the Germans) saw it as a substitute for price cuts.

Those who saw set-aside as complementary to price cuts argued that the political constraints on the rate at which prices can be cut, together with the low supply response to these cuts, necessitated an additional instrument to bring about a quicker reduction in output and thus surplus stocks. It was also part of this view that set-aside payments would provide a degree of income support and stability for the 'marginal' farmers attracted into a voluntary scheme who would thus be attracted to 'retire' from cereal and oilseed production earlier than they otherwise would have done. The presumption was that during the period that land was attracted out of production, prices would be systematically reduced by the other elements of the stabiliser programme (that is, the supposedly automatic price cuts which were to ensue if production exceeded the maximum guaranteed quantity). It would then be highly unlikely that farmers would choose to resume cereal production on formerly set-aside land in the new lower-price environment. In any case, many such farmers would have retired from farming altogether.

The protagonists of set-aside as a stand-alone policy instrument were committed to the support of farmers' incomes through the support of end-product prices. They recognised the high domestic political and budgetary cost of the over-production stimulated by high and stable prices. They also recognised that the disposal of the surplus stocks by subsidised sales in foreign markets attracts international opprobrium. Rather than directly tackle the cause of these problems, that is, the high prices, they prefered to take action against the main symptom of the problem, the over-production. Their approach was thus to take whatever steps were necessary to manage supplies to avoid the necessity to reduce prices.

The resulting five-year set-aside scheme introduced in 1988, has not been a success in achieving any of its declared objectives. By the end of its third year of operation it had diverted 1.9 million hectares from arable production, (about 2 percent of the EC arable area). Ansell and Tranter (1992) documented the UK impacts of the scheme where a similar proportion of arable land was set aside totalling 130,000 hectares in 1991. They concluded that the proportionate effects on output were far lower than the proportion of land set aside. The three reasons for this slippage were: some land would not have been cropped in the absence of the scheme, the set-aside land was the poorer, lower yielding land, and third, yields on the rest of the farm increased a little because of rotational advantage, improved timeliness of cultivation and better operational efficiency of labour and capital. The overall impact of slippage seemed to be that the two percent set-aside reduced production by about 0.75 percent. The performance in achieving budgetary savings was evidently even worse. Rather than saving money compared to conventional surplus disposal, the scheme was calculated to have cost more. A critical assumption in this calculation is the cost per tonne of export refunds. This figure is very variable and a low figure was used on the advice of the Ministry of Agriculture. There was a small net financial benefit to participating farmers from the scheme. However slightly less than half of this came from the set-aside payments. The main benefits resulted from labour and machinery savings (some of which are once-for-all gains) and additional output of remaining crops. It was clear that the main beneficiaries of the scheme were larger farms as smaller farms have far less scope to cut labour and machinery costs by reducing their cultivated area. The value of reduced risk was not quantified. The effect on the environment was not investigated by Ansell and Tranter; anecdotal evidence on this point is mixed.

In 1991 a follow-up one-year voluntary set-aside scheme was introduced to bolster the flagging five-year scheme until the wider reforms of the CAP could be agreed. It was launched with little notice and as a consequence enrolment was low. The inducements comprised a payment per hectare set aside plus the refund of basic co-responsibility levy on eligible grain sold in the 1991/92 production year. An evaluation of this scheme has not yet been published. However it is known that in the UK the area set-aside was less than one-third of one percent of the total arable area.

Before the economic and environmental effects of these two schemes could be appraised, the European Commission (1991) proposed a massive extension of the use of set-aside as part of the package of measures to reform the CAP. This is the subject of the remainder of this paper. Section II summarises the main features of the new proposals. Section III discusses the objectives and likely operation of the new set-aside scheme. In the concluding section suggestions are made as to how the worst aspects of the scheme could be avoided and the steps the Community should take so that it can extricate itself from set-aside as soon as possible.

II THE 1992 CAP REFORM.

The reform measures agreed by the Council of Ministers on Thursday 21st May 1992 embody cuts in cereal support prices of approximately thirty percent over the three years 1993/4 to 1995/6, Agra Europe (1992a). The largely symbolic target prices are cut by considerably more than this from their current level of 212 ECU/t to 110 ECU/t (ie a 48% cut). The published cut in intervention price has been presented misleadingly. The present intervention price for breadmaking wheat is 168.6 ECU/t, however the more relevant price at which intervention actually takes place is the buying-in price which is 155 ECU/t. In practice most farmers would receive 3% less than this because of the co-responsibility levy (CRL). The combined effect of the new intervention price for 1995/6 of 100 ECU/t and the abolition of the CRL, means a cut in effective price support of 33.5%. The corresponding cut in effective support price for the other cereals is from 147 ECU/t less 3% CRL to 100 ECU/t, that is 30%. The publicised 29% cut in prices is the change from the present buying-in price of 155 ECU/t to the new target price for 1995/6 of 110 ECU/t; a comparison which makes little sense.

To compensate for the loss of income resulting from these price cuts, all farmers are to be offered direct payments of 25, 35 and 45 ECU/t for the three specified years. These are calculated as the difference between the 1991/2 buying-in price for breadmaking wheat (155 ECU/t) and the new target prices for cereals of 130, 120 and 110 ECU/t. Thus the compensation offered is less than the price cut for breadmaking wheat but slightly more than the cut for other cereals.

The compensation will be paid per hectare by multiplying the above amounts by regional average yields. It is expected the UK will choose four regions: England, Scotland, Wales and N Ireland. Thus in England with average cereal yields of 5.8 t/ha the payment will be 145 ECU/ha, 203 ECU/ha and 261 ECU/ha (116, 162 and 209 £/ha - using the green ECU for conversion) respectively. Farmers who have customarily produced lower or higher yields than this average will thus be over- or under-compensated. For example, the members of the 'Ten Tonne Club' who regularly produce average yields in excess of 10 t/ha could find their revenues from cereal production are reduced by 426 ECU/ha (42.6 ECU/t times 10 t/ha) with compensation of only 261 ECU/ha, a reduction of 39%. At the other extreme the farmers obtaining low yields say around 3 t/ha could find their revenue is substantially increased (they lose 128 ECU/ha and gain 261 ECU/ha).

To be eligible for these payments farmers with production calculated to be in excess of 92 tonnes of cereals will have to set-aside a minimum stated proportion of their base arable area. This is defined as the average area of Cereals, Oilseeds and Protein crops (henceforth abbreviated as 'COPs') for 1989, 1990 and 1991 plus any fallow or set-aside land in those years. Both the individual farm and the corresponding regional base area will assume significance as explained below. Set-aside land will be subject to various management requirements, the main provision is that it may only be used to produce non-food or non-feed crops. The set-aside may be rotational or non-rotational, although if the latter is chosen a higher proportion of base area may have to be enroled. The set-aside is optional, but the arithmetic of the scheme is such that it is hard to envisage a rational farmer choosing to forego compensation to avoid the necessity of putting land out of production.

Farmers wishing to claim compensation payments will have to register their area of COPs and their area set-aside. Initially the proportion of set-aside has been set at 15% of the sum of these two. This proportion may be changed in the future in the light of circumstances. Another way of calculating the set-aside area is that it should be at least 17.6% (=.15/(1-.15)) of the cultivated area of COPs. Farmers will be compensated for their set-aside at the 1995/6 compensation rate per tonne from the outset, that is 45 ECU/t multiplied by the relevant regional average yield. If it turns out that, collectively, farmers increase their COP area so that the sum of cultivated COPs plus set-aside exceeds the regional base area, then the eligible area for compensation on each individual farm in the region will be reduced proportionately and a corresponding additional area of uncompensated set-aside will be required for the following year.

To summarise, following substantial cuts in COP support prices, farmers will be offered flat-rate, nominal, per hectare compensation for all the area of cereals, oilseeds and proteins planted plus the area of land set-aside which is required on farms nominally capable of producing more than 92 tonnes of cereals. There is a clear incentive for farmers to utilise fully their base area. The only situation where a farmer has an incentive to reduce his cropping below his base area is if there is a net loss per hectare grown which is greater than the compensation payment on offer.

To illustrate the potential areas involved, Table 1 shows the area of COPs in 1989 together with estimates made by Allanson (1991) of the proportion of cereal production on farms producing in excess of 92 tonnes and thus liable for set-aside. It can be seen that the total set-aside area if all farmers choose this option and fully implement their obligations is 3.7 million hectares. This would make set-aside the 7th largest EC 'crop' after wheat (13.4 m ha), barley (11.8), olives (5.0), green fodder (4.6), vines (4.0) and grain maize (3.9). The table shows that the largest areas of set aside would be in France and Spain with some 2.1 million hectares. Combined with the UK and Germany these four countries will account for 87% of the total set-aside. The UK area of about 630,000 hectares would rank as the third largest crop after wheat and barley, and not far short of twice the current 'yellow' area of oilseed rape.

There are numerous unanswered details about the implementation of these reforms and the set-aside in particular.

What will be the regions defining the base area?
What will the regions be for calculating average yields?
What will be the non-rotational set-aside requirement?
Will farmers be allowed to have both rotational and non-rotational set-aside on the same farm?
Does rotational set-aside mean that <u>all</u> arable land must be set aside one year in seven?
How permanent is non-rotational set-aside?
Can farmers opt in and out of the set-aside at will? (They would forgo the payments if they opt out of course).

What sanctions will apply at individual farm level to those who wilfully expand their COPs plus set-aside area beyond their base area?

What evidence will be demanded of set-aside areas and what resources will be deployed in policing the scheme?

What environmental requirements will be imposed?

Some of these questions will be resolved at the Community level, but most will depend on national implementing legislation. It will take two or three years of operation before the answers and their effects will be clear.

Table 1 Maximum Potential Set-aside Area in the EC-12.

	Total eligible area cereals, oilseeds & proteins. '000 ha	Percentage Liable to Set-aside** %	Area Liable to Set-aside '000 ha	Set-aside Area '000 ha	Percentage of Set-aside %
EC-12	41,635	59.7	24,869	3,730	100.0
Belgium	357	54.4	194	29	0.8
Denmark	1,930	69.3	1,338	201	5.4
Germany *	5,159	54.2	2,794	419	11.2
Greece	1,780	9.4	167	25	0.7
Spain	9,255	62.9	5,820	873	23.4
France	11,756	75.6	8,883	1,332	35.7
Ireland	350	62.8	220	33	0.9
Italy	4,983	20.1	1,003	150	4.0
Luxembourg	36	54.4	20	3	0.1
Netherlands	236	53.1	125	19	0.5
Portugal	1,361	8.5	115	17	0.5
United Kingdom	4,432	94.5	4,190	629	16.8

Source: Agricultural Situation in the European Communities, 1991 Report.

Notes: * Excludes former Eastern Germany

** See Allanson (1992)

III THE OBJECTIVES AND LIKELY EFFECTS OF SET-ASIDE

The objectives of the reforms are stated by the Commission (1992) to be:

"(i) to provide the Community farmers with a new and more stable framework within which they can improve their competitiveness and their earnings;

(ii) to redirect support to farmers in a fairer way and in a way which will help control production, stabilize markets and support incomes;

(iii) to provide increased support for encouragement of less intensive production techniques and better care of the environment."

Objectives for individual elements of the package, such as the set-aside are not specified. However previous objectives have been to reduce production and budgetary costs of support, to stabilise and maintain farmers' incomes, and to provide environmental benefits. These will be considered in turn.

Production control

There is a deep-seated, but erroneous belief in the EC that there is a problem of over-production of inter alia cereals. The existence of significant stocks, over 20 million tonnes in spring 1992 (which is 14% of annual consumption), and the large budgetary cost of subsidising exports to prevent these stocks rising still further appear to provide clear evidence of this problem. From an economic point of view the problem is not the level of production, but the artificially maintained, high price level which prevents the market reaching balance. If the present levels of production were produced, and sold at internationally competitive price levels the 'surplus' would be called exports and considered a thoroughly good thing. The politicians and bureaucrats who have taken on the role of market managers seem incapable of focussing on the problem in this way. Because they have either no knowledge of the existence of systematic relationships between prices and levels of production and consumption, or no faith in their operation, they are not prepared to leave prices alone but choose to manipulate them in a vain attempt to achieve farm income and other goals. The fear that continued technical progress will further increase the 'over-production' problem intensifies their view that government must take action to prevent market imbalance growing.

The significant price cuts in the 1992 CAP Reform could be interpreted as a partial indicator that politicians have grasped the point that price supports are the source of the market imbalance and that these supports were not achieving the income support objective either. However it is equally clear from the reluctance to reduce prices all the way to the international price level, and from the introduction of a community-wide, effectively compulsory set-aside scheme, that the politicians are not prepared to let go of their deeply-ingrained habit of market management.

The experience in the United States where cropland diversion programs have been in use since the 1930s is that they are inefficient ways of controlling production, Ervin (1988). The proportionate reduction in output is always below the proportion of land set-aside. This results from additional land coming into production, from the worst land going out of production, and from the enhancement of productivity on land remaining in production. Of course the extent of this slippage depends on the precise economic circumstances, the rigour of the rules, the sanctions for transgressions and the resources and efficiency of administration. However, regardless of the resources deployed to make the scheme as water-tight as possible, fundamentally the scheme is 'unsafe'. Producers are to be offered money to idle resources which instinctively they would prefer to put to productive use. This cannot fail to induce behaviour which undermines the objectives of production control and budgetary savings. Thus the first charge against set-aside is that it is aimed at an inappropriate target and it will always be an inefficient way of achieving its primary goal of reducing output.

The framers of the set-aside proposals are aware of these problems. This is one of the reasons they have exempted the large number of smallest producers. Allanson (1991) calculated that 90.5% of the 4.3 million cereal growers in the EC-12 will be exempt from set-aside, (the corresponding UK figure is 45%). The reason that the initial proposals suggested all set-aside should be rotational was to minimise slippage. However, this proposal was not accepted by the Council. To make matters more difficult, there is a clear conflict between the achievement of the production control objective and that of increasing the international competitiveness of EC agriculture. The first goal suggests focussing attention on the largest producers in the most important producing regions. However this group will contain most of the efficient producers. Furthermore, those who will be most resistant to idling land will be those who have stewardship of the most productive land. The loss of efficiency resulting from the set-aside and proposed compensation arrangements is discussed in Haynes et al (1992). They listed four ways in which competitiveness will be inhibited by the reforms:

(i) The loss of economic output from the enforced idling of productive resources, valued at 300-400 m ECU/year.

(ii) Raised unit production costs of cereal growers because of loss of size economies, valued at over 200 m ECU/year.

(iii) Some land will be retained in COP production which would otherwise go out of production in the new price regime. This will occur because compensation payments are based on areas planted and thus these payments will be lost if sub-marginal areas were switched to alternative uses.

(iv) The comprehensive strait-jacket of the new CAP: quotas on milk and sugar; base areas for cereals, oilseeds and protein crops; and headage and stocking rate restrictions for sheep and beef, drastically restricts the room for manoeuvre for EC farmers. It may thus slow structural change and inhibit the process of achievement of scale economies.

Without the answers to the questions listed in section II it is difficult to quantify the production impact of the combination of the impending price cut and set-aside. Because of the exemption of small producers and the incentive effect of the compensation payments, the area of COPs will be reduced at most by the area suggested in Table 1 (ie 9%). The net effect of reduced intensity of use of fertiliser and crop protection chemicals because of the price cut, offset by continued technical progress is hard to predict. Because it will be the highest yielding producers who are least generously compensated for the price cut, and it is these who are the heaviest users of fertilisers and other chemicals, it is likely that there will be a noticeable net reduction in overall yields. Thus production will fall, and it could be by as much as 10% by 1995/6 compared to current output.

Budgetary costs

Whilst the inexorable growth in the real budget cost of the CAP has been a continuing pressure for the reforms now agreed, it is not clear that the reforms themselves will allow these costs to fall. It is useful to draw a distinction between the total budget cost of agricultural policy and the specific costs of the set-aside component. As the overall direction of reform is to replace price support with direct payments, unless the total extent of support is to fall it must be presumed that total budgetary outlay will rise. However the set-aside component of the package is one area where budgetary savings might be expected. Why pay farmers not to produce if it is cheaper to let them produce and then dispose of the surplus? Which is cheaper?

The answer depends on likely changes in the cost of export subsidies compared to the cost per tonne 'saved' by set-aside. According to the EC submission to the GATT secretariat, the average costs of export subsidies for the five year period 1986 - 1990 was 107 ECU per tonne exported, (Agra Europe 6/3/92). If it is assumed that the 30% fall in support prices brings about a corresponding 30% fall in market prices, then the gap between EC and external prices will fall by considerably more than 30%: for example by over 50% to 55 ECU/t. Even this includes no allowance for world prices to rise or the ECU to weaken against the dollar, both of which would reduce this cost. This should be compared to the cost per tonne saved by set-aside. The compensation offered is 45 ECU/t times the regional average yield per hectare. If the land set-aside has average yield and there is no enhancement effect on remaining land, the cost per tonne saved would thus be 45 ECU. Neither of these provisos are likely to hold. To save budgetary costs by not producing grain, the net yield per hectare set-aside will have been at least 82% (=45/55)of the regional average yield. The evidence of the voluntary schemes implemented to date in the EC is that this condition will not be met. It also has to be noted that the calculation makes no allowance for higher administrative costs for set-aside compared to exporting. The judgement a priori must be that set-aside is highly unlikely to provide budgetary savings.

Farm income effect

It has already been noted that the compensation offered for price cuts will not fully recompense the gross revenue loss of farms with average and above-average yields. The effect on these farmers' net incomes is hard to judge without further detailed analysis. Two mitigating effects are that the cuts in product prices will induce cuts in usage of certain inputs and thus in their prices, and that the compensation payments will have less uncertainty (in the short run) than actually growing crops. The overall effect is still likely to be reductions in expected net incomes for these farmers. This group will also lose on the area they set-aside. The compensation available per hectare looks reasonable compared to the existing voluntary set-aside schemes, especially as prices will be lower. But the net revenue from growing cereals is much higher than 261 ECU/ha for average and above average farms. This is true even after adjusting Nix(1991) gross margins for a 32%-35% price cut and making no allowance for lower input costs. Such calculations yield gross margins ranging from 244 ECU/ha for average yielding spring barley to 541 ECU/ha for high yielding winter wheat of milling quality.

The conclusion is that all but the smallest cereal growers (who are exempt from set-aside) will have lower net incomes, and for some, perhaps considerably lower. There are three savings which may offset such reductions: the greater degree of certainty of the compensation payments, some savings on overhead costs and less work to do because of the set-aside and less intensive production. These are unlikely to offset the losses.

Environmental effects

Measuring progress according to this criterion is much more complex and difficult than any of the above three criteria. It is useful to distinguish three sub-categories of environmental effects in which society is interested: landscape (both man-made and natural), biodiversity and resource protection (which would include pollution and soil erosion). The US experience in this area is mixed (Ervin et al (1991)). There is a consensus that long-term soil and wetland conservation schemes have been successful in resource protection. The achievement of the other environmental goals is much less clear, the targets themselves are less well defined and devising schemes and ensuring compliance is much more difficult, Potter (1991).

Landscape features such as hedgerows, small woods, ponds, ditches, stone walls and vernacular architecture have all suffered as a result of the technical and structural changes in agriculture. The high price regime has no doubt played a part in this process. In the new economic environment the pace of these changes may well be reduced and so the rate of loss of these features may slow. However a further squeeze on farming profitability per hectare will not eliminate the benefits of further farm and field enlargement which probably cause most of this damage. Furthermore, the listed features will not regenerate themselves. These are the aspects of the countryside which farmers will not maintain if they are financially stressed. They are classic non-market goods for which society will have to create incentives and pay collectively.

Similar conclusions probably apply to the natural and semi-natural features of the landscape: marsh land, heath land, herb-rich meadows, and much of the upland landscape. Many of these habitats or features also require positive management and thus real resource inputs. Some, for example wetlands, may reappear slowly if land is not fertilised, drained or intensively grazed. Whether they reappear as a result of set-aside will depend entirely on the provisions of the non-rotational scheme.

Damage to biodiversity by pollution of soil, rivers, aquifers and atmosphere and soil erosion are side effects of the trend to more chemical- and machinery-intensive farming. These are trends which are more likely to reverse as the new economic environment reduces incentives. Reduced total output will mean reduced total input; whilst controversial, this view is shared by the manufacturers of these products, Financial Times (1992). The precise spatial distribution of these changes is, of course, critical in determining their effects. Whilst rotational set-aside which is either sown to a green cover crop or left to regenerate will not yield a herb and fauna rich habitat, it will have more species than the crop it follows and may well contribute buffer zones and wildlife corridors which do make a noticeable difference.

Overall, the CAP reforms will slow if not halt the post-war trend of environmental damage caused by intensive farming. The relative contribution of price cuts and set-aside to this amelioration will be difficult to separate. The reversal of the trends will not come about by these policies alone. That will require very positive identification of environmental goals and specific and targeted interventions to achieve them.

IV CONCLUSIONS

The fundamental objective of set-aside is to reduce output. All the experience inside and outside Europe is that it is a poor instrument to do this. But the justification for reducing output is far from clear, its main purpose is to avoid having to eliminate price support. Yet it is recognised, even by the European Commission, that price support does not support those farmers whose welfare is of most concern. Thus set-aside is a flawed instrument of agricultural policy. Arguments and evidence has been cited that it is no better at achieving other objectives set for it: reducing budget costs of support, providing farmers with a fair standard of living,or providing environmental benefits. Set-aside can contribute to this last objective, but only if it is specifically designed and targeted to do so.

These arguments are not new (see Buckwell (1986)), and the decision to go ahead with set-aside has now been taken. The following suggestions are made to minimise the frustrations, restrictions, distortions and losses which now lie ahead.

Pressure should be maintained to continue the reductions in support prices beyond 1995/6. It is extremely difficult to determine in advance, the price at which EC crops become internationally competitive. Such calculations require assumptions about other countries' policy, international market trends and interactions. But it is not necessary to know this price in advance. It will be abundantly clear that the international price is close when it is possible to export EC cereals without seeking public subsidies to make the price attractive. In other words, there will not be a regular build-up of unsaleable stocks. To maintain the downward pressure on prices, intervention conditions should be kept tight, and aids to private storage and export refund offers minimised. The aim of intervention buying should be intra-year stabilisation and not inter-year support. Such action will not be sufficient on its own to reduce trade distorting protection. There will still have to be a conscious effort on the part of the Council of Ministers to continue to reduce the support prices. The carrot they can offer farmers is extended direct payments in one form or another, and relief from set-aside.

It is hard to see the Council summoning the will to take this action in the near future. Thus in the meantime we will have to live with set-aside. To minimise its distorting effects, it is suggested that a clear distinction is made between the long-term set-aside destined to create specific environmental benefits and the rest. For the former there must be restrictions and rewards to ensure the environmental goal is achieved. For the latter it is preferable that the rules are kept as simple as possible, there are as few other distinctions in treatment of different farmers and as few restrictions on farmers as possible. This should be seen as a temporary device to enable the EC to be seen to be doing something to relieve international market distortions, but to be abandoned at the earliest date.

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